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United States Naval Institute Proceedings

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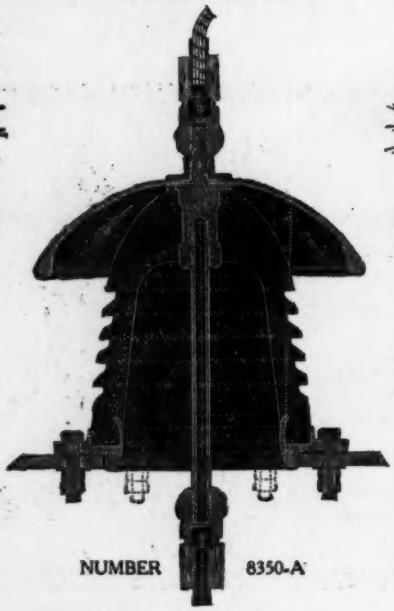

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United States Naval Institute

Proceedings

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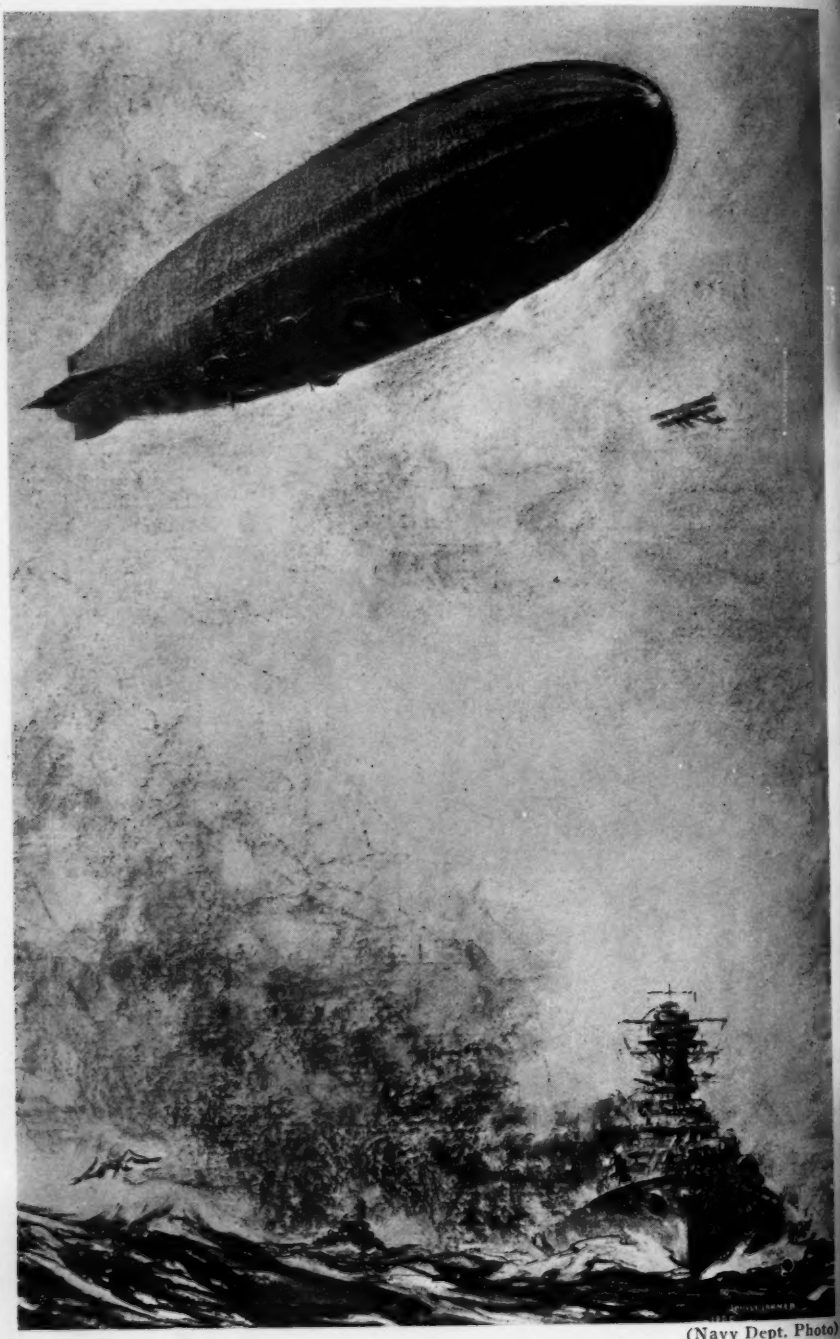

(Navy Dept. Photo)

SKETCH OF RIGID AIRSHIP OPERATING OVER THE SEA.

SPECIAL NOTICE

Supplementing the Special Notice regarding address, which appeared in the last issue of the PROCEEDINGS, the Institute wishes to further inform its members and subscribers that the Bureau of Navigation has discontinued issuing the monthly *Navy and Marine Corps Directory*.

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UNITED STATES NAVAL INSTITUTE PROCEEDINGS

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ONWARD AND UPWARD

By Rear Admiral H. S. Knapp, U. S. Navy

In the leisure days of retirement it is a natural impulse to look back over the incidents and tendencies of one's active service. In reviewing since retirement the forty-two years of my own service I have been particularly impressed with the development of thought in the United States Navy. Those years cover a period of remarkable material advance and achievement in human history as well as in the more limited way of naval history. It is a very wonderful time in which to have lived. Speaking of the navy alone: we have advanced from wood to steel in construction; from compound through triple and quadruple expansion engines to turbines, and now to electric drive, or to oil engines in particular cases; from speeds that tramp steamers now attain to speeds rivaling those of express trains on land; from smooth-bore guns to 16-in. rifles, with 18-in. guns under discussion; from spar and towing torpedoes to automobile torpedoes having a range of thousands of yards; from vessels restricted to the surface of the sea to those that operate under water or in the air; from loss of communication when beyond sight and hearing to assured communication over hundreds, even thousands, of miles. Truly! by comparison with conditions in the early days of my service this is a material advance staggering to contemplate.

But it is not so much to this material advance, stupendous as it is, that I would draw attention as it is to the evolution of naval thought. It so happens that my active service coincides almost exactly with the period of life of the Naval Institute, in the pages of whose PROCEEDINGS has been mirrored the naval thought of the day, to a great extent if perhaps not entirely. To the readers of the PROCEEDINGS through the years since the Naval Institute was founded there has been apparent a change in the general character of the articles that have appeared. The navy was at a very low ebb in its material when the founders, a group of far-seeing officers devoted to the service, conceived the idea of the Institute and made it a reality. Very naturally, stress was laid in those early days upon remedies for the discouraging material conditions then existing. Ships, armament, motive power and equipment were far behind even those times, and officers were concerned to get material worthy of our great nation and suitable to uphold its interests should occasion arise. How best to use what we did not have could not be expected to hold the attention of officers as against the more urgent question of getting adequate means with which to do anything. It was a time when material things held the stage.

In passing, however, I pause to express my admiration for, and feeling of great indebtedness to, the officers of the generation immediately preceding my own, who kept alive the spirit of the navy in that deadening time after the Civil War before the rehabilitation of the navy had begun. Using the means at hand, hoping almost against hope for better days, those officers maintained the discipline of the service, preserved its traditions and ideals, and kept it in readiness for better days if and when they should come. To them we owe the fact that the soul of the navy was not moribund when better days did come, and the navy's debt of gratitude to them should never be forgotten.

The founding of the War College was an epochal incident in the history of the navy. It would be untrue to say that the subjects for the study of which the college was established had not had attention before it was founded. There always had been officers who looked beyond the thing to its use—beyond the organization to its mission. Such officers were, however, self-taught; their opinions were individualistic, formed by their own interpretation of political and naval history or their own predispositions for or against given methods in using the material of the navy in war,

without having the advantage of any save incidental discussion with others. Opinions so formed might or might not be sound; certainly they could not be held to be as well-founded as if they had been subjected to intelligent discussion and criticism. Moreover, it was the few whose natural tastes led them in that direction who gave the broader aspects of the profession much thought or who had any very fixed views regarding them. For the many it was the material *things* of the navy that were obvious and so obviously bad as to fix attention to the exclusion of much consideration of their use. There was no service body of opinion—no doctrine—in this latter direction, and no agency to demand attention to it and assist officers in its study. Indeed! many experienced officers believed that there was no need for any such agency. Apparently they believed that strategy, tactics, and, speaking generally, the broader subjects upon which officers should be well instructed, needed no special study under competent direction, with the enlightenment that comes from discussion with others pursuing the same subjects, but that correct ideas about them would be imbibed like mother's milk as a result of everyday, routine experience. Young officers of this generation, to whom the War College is a fixed and natural institution, can have little notion of the bitter opposition it experienced in its early days from officers high in the service—men of established reputations for ability, moreover.

Fortunately these reactionary sentiments did not prevail and the War College survived, growing from small beginnings to its present acknowledged and undisputed place in the preparation of officers for the higher duties of their profession. The principles of warfare in general, and of naval warfare in particular, as deduced from an analytical study of history, their application to strategy, tactics and the cooperation of land and sea forces, the methods to analyse problems and reach conclusions, the question of security and information, including sea scouting, the formulation of clear-cut orders, psychology, international law, naval policy, national policy—such subjects are now studied, studied together, by groups of officers having no other duties. Their discussions clarify the subjects in hand, and tend to make conclusions sound because reached after consideration and criticism from many points of view. Since the founding of the War College it has slowly but surely come to pass that these subjects are not strangers to the

thought of the great body of officers, and there is now a service doctrine that embodies a general, instructed opinion.

This marks a great advance in the thought of the navy—in its professional culture. Moreover, it has not been accomplished at the expense of thought on material things. Indeed! I believe that never has keener thought been given than now to material of the navy, the importance of which needs no argument. Thought on other and higher phases of our profession has simply been superimposed upon thought on material alone, a result that follows the law of culture. The navy is professionally more cultivated now than formerly because its general field of thought has been broadened.

If the professional period be characterized by the prevailing trend of thought, that since the War College came into being may be described by the word intellectual to differentiate it from the material period that preceded. Reference has been made in an earlier paragraph to the Naval Institute and to its PROCEEDINGS. While the PROCEEDINGS is in no way an official publication it undoubtedly does serve in a general way as an index of the thought of the navy. Those who have read it since it was first published will agree that the evolution of professional thought outlined above has been manifested in its pages. With the advance of professional culture in the navy there has been a corresponding advance in the interest, breadth and value of the articles that have appeared in the PROCEEDINGS.

There is another evolution in naval thinking that has impressed me greatly, more especially during the recent past, and which is in large measure the inspiration of this paper. It is not an evolution due to any discovery, nor is it one having as fixed a date of beginning as was the establishment of the War College for what I have called the intellectual period. It is rather an evolution due to an awakened consciousness of the truth that man is greater than his creations, or than his management of them; and that the study of men and of the way to influence and manage men—leadership, in a word—is the highest duty of a naval officer. When we speak of "The Service" we refer to men and their attributes and not to things, whether consciously or not. The officers of the service set its tone, which will be high or low as the officers are of high or low character. The enlisted men are what their officers make them; yes, and the junior officers are what their seniors make

them. This is true in the active sense of what officers require of those under their command, and is no less true in the passive sense of the example they set. Those are no idle words in the articles for the government of the navy that open Article 1: "The commanders of all fleets, squadrons, naval stations and vessels belonging to the navy are required to show in themselves a good example of virtue, honor, patriotism, and subordination." Nor does the fact that the injuction specifies certain officers detract from its moral binding force upon all officers, for all officers have men under their command. The traditions of the service are the legacy of the right-minded officers who have lived before us, and those who carry on have the high responsibility of personally living up to them and of ensuring their maintenance by those whom they command.

The awakened consciousness of which I have spoken is shown by measures directed by the department; it is shown no less by the character of many articles appearing in the PROCEEDINGS. Such matters as training, morale and leadership are receiving increased attention. They are the "visible outward tokens of inner spiritual grace," and the quotation is made in no spirit of levity. The navy has a spiritual side and it is well that its existence should have recognition. In my sense of the words that spiritual side includes everything bearing upon men—the welding of officers and men of the service into the most perfect instrument possible to accomplish the purposes for which the navy exists. Training, education, character building, the inculcation of the spirit of team-work, the breeding of confidence in the support of one's neighbor, the infusion of the belief that we cannot be beaten, the cultivation of the spirit that was voiced by the French at Verdun in those famous words "They shall not pass"—all these are spiritual things. Men win battles. The finest ships are inert things unless men drive them; and men are poor things unless the spirit be high that drives them. Great intelligence at the top is not sufficient; it will not prevail unless the spirit behind it be firm and unshakable, nor unless it be backed by trained, disciplined, determined men of high morale.

The development of men, of ourselves first and then of those whom we command, is the highest work of naval officers; and it is spiritual work as differentiated from preoccupations with material, or even with the intellectual side of the profession of which I have

spoken. To find the spiritual side of the profession receiving increased attention, as I believe it is, is a most heartening thing. The successful development of men has its roots deep down in character. To say in other words what has already been said, the source of the spiritual conceptions of the navy resides in the officers, and no stream rises higher than its source. It is manifestly of the utmost importance that officers hold and maintain in themselves the highest conceptions if they can hope to inculcate them in others. The obvious consequence is that the very first field of an officer in the development of men is to be found in himself; that his first concern is to build well his own professional and personal character. Leaving aside considerations of personal honor that naval officers share with decent men, and without which no one is fit to hold a commission, the officer of high professional character will be proficient in his immediate duties, will study constantly to fit himself for the higher duties that await him, and day in and day out will strive for the qualities in himself that make for success in the leadership of men. He cannot ignore the material with which he has to work, nor the intellectual consideration of how the material of the navy is to be used; still less can he ever forget that his life-work is with men—that his choice of a profession entails his occupying a position of leadership of men, and that he can never be a success unless he is a worthy leader.

No officer is a good officer, whatever his abilities and accomplishments, if he cannot "handle men," to use the time-honored naval expression. The ability to handle men is admittedly a greater natural gift with some than with others, but it is fundamentally a question of character and it may be cultivated by all. If it is not cultivated—and attained—an officer is to that extent a failure. Men have no use for an officer who does not know his own business thoroughly; such an officer lacks character because any officer can know his business thoroughly if he tries. Men have no use for an officer who is not just, and the failure to be just betrays a lack in character that can be and should be corrected. Some officers are hampered in their relationships with men by faults of temperament; if they do not overcome those faults they are wanting to that extent in character. It is needless to multiply illustrations. If my thesis is correct that character underlies the handling of men, then every officer must cultivate leadership by cultivating his own character, and no officer need be a failure at it. Some will alway-

be better leaders than others, as is true in every human activity, but all can be reasonably good. If any officer lacks the character to reach such a reasonable standard he should leave the service, voluntarily or involuntarily.

Just here in the writing of this paper the current number of the PROCEEDINGS has arrived. It contains two articles out of six on matters pertaining to spiritual things, one on leadership and one on loyalty. Loyalty is one touchstone of character, not the only but a very important one. No military character is worthy unless it can stand the test of loyalty—loyalty to the ideals and traditions of the service; loyalty to the duty in hand; loyalty to the seniors who prescribe that duty; and, a thing never to be forgotten, loyalty to the juniors, officers and men, who carry that duty out. This last sort of loyalty has a direct application to the training of men (and by men I mean all men, commissioned or enlisted), which is second only to his duty to train himself. To instance one very obvious thing, nothing excites more contempt than the sort of disloyalty that seeks to shift to the shoulders of a junior blame that belongs to one's own. But "loyalty down" means far more than this. The object of training is not merely to have men ecquire manual dexterity in the performance of special duties or to make them live their service life in conformity with established rules. It is all this, no doubt; but more than this, it is to inspire men with the desire to do these things, a concern of the spirit. True loyalty down will not leave an officer content to get perfection in drill and obedience to regulations on the part of juniors. It will by example, by precept, by patience, by justice, by the decent treatment due to his own respect for the manhood of his juniors, and by commanding their respect for his own character and attainments, lead him to cultivate their will and spirit to a high sense of duty and loyalty so that because of him, yes! for love of him, they are finer and better men, whether of society in general or of the service in particular.

Example is probably the most potent influence an officer can exert; if this be a platitude it will bear repetition. Leaving aside the bearing upon "loyalty up," can an officer feel that he is manifesting loyalty down if he is unshaved or slack in uniform himself while insisting that his juniors be tidy in these respects? if he demands perfection in a drill of which he does not know every detail himself? if he is harsh in language or manner to subordinates

in a way that he would resent if manifested toward himself by a senior?—to mention only a few things in illustration. There can be only one answer. "Do as I say and not as I do" is a rule of conduct one hears occasionally, but spoken at all seriously it is a confession by the speaker of his own shortcomings and betrays a failure in loyalty up to his duty and his seniors, and in loyalty down to his juniors. Every consideration of what I call the spiritual side of the profession leads back to the high responsibility of officers to "show in themselves a good example."

The word "morale" has appeared in the PROCEEDINGS of late with increasing frequency. Morale has nothing to do with material things and very little to do with intellectual attainments. It is essentially a matter of the spirit, a resultant of spiritual qualities. The word ordinarily applies to bodies of men rather than to individuals, as when we speak of the morale of the service. It is a composite, however, of the individual morales of its personnel, a weighted mean of those individual morales where the greater weights are given to the higher positions in the naval hierarchy. Like all averages it can never equal the greatest individual value. What every officer can and should do is to attempt to raise the average by setting for himself personally the highest ideals and standards, and then by studying in every way to raise the morale of those under his immediate influence. It is especially important in our navy that this be kept consciously and constantly in mind because of the fact that our service is one of short enlistments in which the proportion of reenlistments is relatively small. The ranks are constantly being diluted by men whose service morale is low, if only because unformed, and thus the average is reduced.

The preparation of this paper was interrupted by my attendance at the graduation ceremonies at the Naval Academy, where the main thought of the last few paragraphs was the theme of Mr. Secretary Denby's address to the graduates. What had been in my mind so much during the preceding weeks found confirmation in the words of a man singularly qualified to pronounce judgment. I have never been an enlisted man; Mr. Secretary Denby has been an enlisted man as well as an officer, and in both the navy and the marine corps. With the knowledge gained by an educated man of the viewpoint of both enlisted men and officers, his words on such a subject carry a weight far transcending the respectful attention that would be given in any event to the man holding his high office.

These reflections have been the result of a backward look upon more than forty years of active service, but they are combined with a confident look forward to the future. I believe in the service to which it is my honor to belong—in its high ideals, its high standards of character and attainment, and in its spirit of progress. I left active service with an intense pride in the navy which I may be forgiven for expressing to my brother officers. It was not my fortune to have any part in actual war operations, but I saw officers about me doing distinguished service in other and unusual fields while eating their hearts out with the desire to be at the front. The duty in hand never suffered because of that natural desire and the disappointment that it could not be gratified. Later, in the trying times after the Armistice, I was in a position to observe officers on duty in Europe, and my respect was unbounded for the spirit in which duties of all kinds were undertaken, as was my respect for the manner of their performance. Many of those duties were unusual, quite out of the range of a naval officer's ordinary activities, and demanding a high degree of responsibility, often greatly out of proportion with the rank of the officer to whom they fell; but they were done, and done well.

The navy is on the upgrade. This is not said in unreflecting optimism, for I do not believe that all that is is best; but I have little patience with the growlers who declare that the service is going to the dogs. I know that the navy is a better establishment now than when I first put on its uniform. It is better in material, far better; in its instructedness in the methods of using that material and, speaking generally, of accomplishing its mission it is incomparably advanced; and it is giving attention more than ever to what seems to me the all-important spiritual side. Moreover, the navy works much harder now than then, which surely is no sign of a deteriorating spirit. I do not believe that the evolution of the service has stopped. So, if these words carry any message, it is one of hopeful confidence that the course of the service in the future will be onward and upward,—in material, in intellectual instructedness and in the higher spiritual qualities without which material and intelligence are incomplete.

The navy has a soul; and, like the soul of John Brown, the navy's "soul goes marching on."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AERODYNAMICS[1]

By COMMANDER J. C. HUNSAKER (C. C.), U. S. Navy

A series of lectures on different aspects of aeronautics has been arranged, of which this is the first. As I am to prepare the way, I shall discuss only the principles of aerodynamics, the fundamental science built up by generations of patient experimenters and only in our own time turned to practical use. The succeeding lecturers will instruct you in the various kinds of aircraft and their operation. To-night, let us consider the nature of the air itself which supports all things that fly in it. A good deal is known and more is unknown. However, enough is now known to permit man to fly.

The use of steam was ushered in by the 19th century, and conditions of life on our planet have been profoundly changed. We may well wonder whether the conquest of the air will as profoundly affect life during the 20th century. Certainly in the naval service, new ideas are already crowding upon us.

THE OCEAN OF AIR

We live near the surface of separation between the ocean of water and an even deeper ocean of air extending above us. These oceans are in many respects similar. In each, there are the twice daily tides and great currents circulating in definite courses, *e. g.*, the trade winds and the prevailing westerly winds.

We know a little about the top of the sea and the bottom of the air. To explore the sea below or the air above, we make soundings. Soundings show that the sea is colder as we go deeper and the air colder as we go higher. Both oceans receive their heat from the sun at their surface of separation.

[1] A lecture delivered before the first class of midshipmen, March 11, 1921.

Deep sea fish live at enormous pressure and burst if brought to the surface. In a similar manner men live at the bottom of the ocean of air under the enormous pressure of 15 lbs. per sq. in. or about 1 ton per sq. ft. A man's body has about 20 sq. ft. of surface, so that each of us is supporting at all times 20 tons. We do not feel this weight because we are adjusted to it, but when the pressure is partly relieved as when we go up a mountain or up in an airplane, the effects are painfully evident.

The atmosphere extends for an indefinite distance but becomes very thin after a few miles. Men have gone up about 6 miles in airplanes and sounding balloons have been sent up about 14 miles. The cirrus clouds we see in fine weather are about 9 miles high. Meteors that blaze in the night are heated by friction with our atmosphere. The evidence from the spectrum of meteors is that the atmosphere is mainly hydrogen at the top.

The principal difference between the oceans of air and water is that the sea is substantially of the same composition at all depths, while the atmosphere is a mixture of gases in different proportions for different altitudes. As we go higher there is less oxygen. This aggravates the sickness caused by diminished pressure. At 15,000 ft. men begin to feel "mountain sickness" and above 20,000 ft. it is usual to require an oxygen breathing outfit.

Figures 1, 2, 3 and 4 show in very condensed form the principal characteristics of our atmosphere.

PHYSICS OF THE AIR

Air at sea level weighs about an ounce to the cubic foot or 1000 cu. ft. of air weighs 80 lbs. Since 1000 cu. ft. of hydrogen weighs only 5 lbs., it follows, by the principle of Archimedes, that 1000 cu. ft. of hydrogen has a lift or "buoyancy" in air of 75 lbs. This is the basis for the lift of balloons and airships. The air in this lecture hall weighs about 5 tons. All types of aircraft (balloons, airships, dirigibles), which gain their lift by the buoyancy of a light gas are called "Lighter-than-air," and the regulation of their movements by releasing gas or ballast is called "Aerostation." I know of no aerostation in nature but the fish's bladder regulates his buoyancy in water (ballast tank of a submarine) in an identical manner.

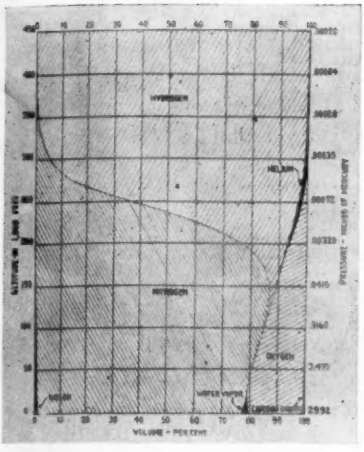


FIG. 1.—Constituents of the Atmosphere.

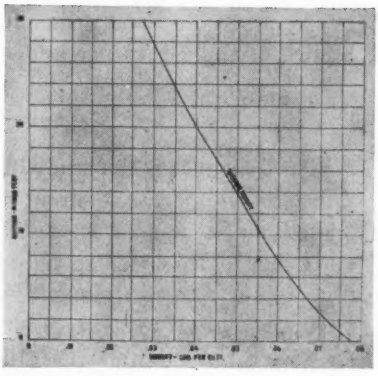


FIG. 2.—Average Temperature Variation.

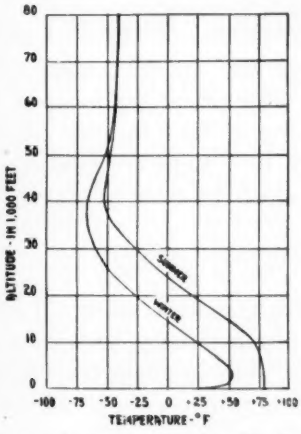


FIG. 3.—Average Density Variation.

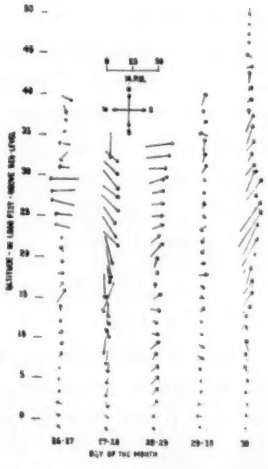


FIG. 4.—Actual Distribution of wind in "Calm" Weather. (Typical Case.)

Birds, insects, kites, parachutes and airplanes gain lift, not by any inherent buoyancy, but by the dynamic reaction obtained by beating down the air. Air is dense and by throwing it down we gain a momentary lift. To sustain a weight in the air, a mass of air must be continuously deflected down. The regulation of the movement of such "heavier-than-air" craft is "aviation." The fundamental laws and principles of aviation are embraced in that branch of applied science known as "aerodynamics."

AERODYNAMICS

Aerodynamics is the study of the motion of air and its dynamic effects. The phrase, "air in motion," implies motion relative to something serving to fix axes of reference. For our purposes, it is useful to consider only air moving relatively to a solid object such as an airplane. By the principle of relative motion, we know and may verify that it is immaterial whether the airplane fly steadily at 100 miles an hour through still air, or whether it fly at the same "air speed" into a steady wind of 100 miles per hour. In the latter case, to an observer on the ground the airplane appears to be stationary. However, the force of the wind striking the wings is the same in either case, and at night, or above clouds the aviator would not know whether or not he is making any speed over the ground, "ground speed."

Without making an excursion into the mathematics of the modern theory of relativity, we may accept for aviation, whose speeds do not approach the velocity of light, that the relative air speed may be used in accordance with Newton's laws regardless of "ground speed" or the motion of the earth in space.

SOUND WAVES

Air, at the ordinary levels where life can be sustained, is under such a great pressure, or head, that it behaves like water. That is, it is practically incompressible. For example, the pressure of the air on the bow of an airship is 12.5 lbs. per sq. ft. for a velocity of 70 miles per hour. This is only about one half of one per cent of the barometric pressure, and for practical purposes the compression of the air at ordinary transportation speeds is negligible. For projectiles and rockets, however, velocities above the velocity

of sound in air are realized, *i. e.*, over 740 miles per hour, and compression becomes important. Sound waves are produced from the point and rear edge of a bullet and represent a definite transfer of energy from the moving bullet into compression waves in the air. This loss of energy means resistance to motion.

Fig. 5 shows a photograph of a bullet making sound waves. The sound wave is a compression wave of air, and is visible in the photograph because the compressed air has a changed refractive index. In the case of this bullet, the velocity is greater than the velocity of sound, so that the waves of sound trail behind the bullet in a conical sheet resembling in section the bow wave of a ship, instead of spreading on a spherical wave front resembling in

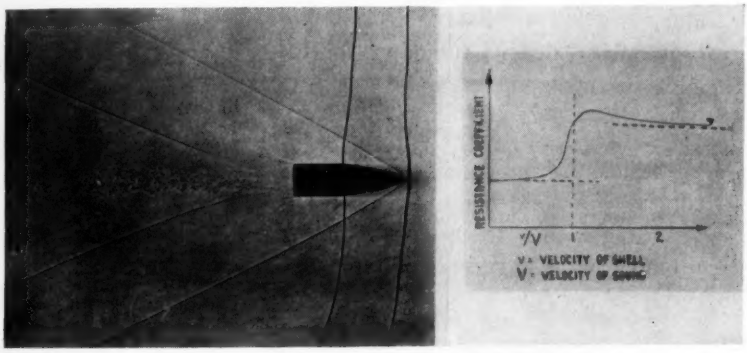


FIG. 5.—Sound Waves in Air. The Heavy Vertical Lines Are the Wires of a Chronograph Cut by the Bullet.

section the circular waves produced by dropping a stone into a pond. It is of curious interest to observe that when a man hears the scream of the bullet, the missile has already passed him. In other words, a man cannot hear the bullet that hits him.

DENSITY RESISTANCE

The air is under such a great head that there can exist no voids or holes in it. Were such a hole created, air would flow in with the velocity of sound to fill it up. Nothing short of a high velocity bullet can produce true cavitation in air. But since air has density it must be pushed aside to permit the passage of a moving body. The work of pushing aside the air is manifested as resistance to motion,

and the resistance of a body is greater the more violent this shoving away of the air. Consequently, a body is easy to drive when it parts the air gently and allows the air to close in smoothly behind as it advances. A body of bad form leaves behind it a large wake more or less turbulent. Momentum imparted to the air represents work done on the air and a resistance to motion. This resistance depends on the shape of the body and is represented by an expression of the form:

$$R_d = adAV^2$$

where a = a coefficient for a given geometrical form,
d = density of the air,
A = the cross sectional area of the body,
and V = relative velocity.

R_d is called "density resistance" because due to the density of the air.

Viscosity Resistance

Air besides having density has viscosity. It is sticky and tends to adhere to a solid body moving through it. A fluid shear or viscous drag is thus set up giving rise to a "viscosity resistance" represented by an expression of the form:

$$R_v = b\left(\frac{u}{d}\right)^{0.5} A_s^{0.75} V^{1.5},$$

where b = a coefficient for a given geometrical form,
u = the coefficient of viscosity for air,
A_s = the area in shear, or outer surface of the body,
V = relative velocity.

True viscous resistance is only found for extremely slow motion. Ordinarily, in water or air, where there is discontinuity of velocity, as where moving air is in contact with air at rest, the flow is unstable and the surface of discontinuity breaks up at once in vortices or eddies. There is then an abrupt change in resistance caused by the energy lost to these eddies. Density resistance is in practice always found in addition to viscosity resistance, and the exponent of V even for a thin plate moving edgewise lies between 1.5 and 2. "Skin friction" is the term applied to such a combination of viscous drag with small "friction" rollers or eddies peeling away from the skin of the body. Such friction rollers can be

clearly seen by looking over the side of a vessel moving in smooth water. The steady flow of viscous fluids in pipes at a certain critical velocity breaks into turbulence. The internal shearing forces are in unstable equilibrium.

The instability of discontinuity I can illustrate by the sensitive flame. This gas jet is adjusted to give a long silent jet of flame. The flame distinguishes the moving gas from the still air around it. There is discontinuity of velocity at the boundary of the flame. This enveloping sheet of discontinuity is unstable, as is shown by a shrill whistle which causes it to break down. The flame breaks down and roars when jarred by the sound.

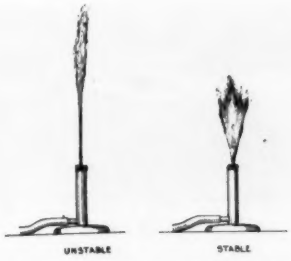


FIG. 6.—Sensitive Flame Before and After Shock Caused by a Whistle of High Pitch.

DISCONTINUITY AND TURBULENCE

The path relative to a moving body of a particle of fluid is called a stream line. When the stream lines about a body are steady and continuous the fluid follows the contour of the surface of the body. If there be changes of form, the fluid must follow these changes. Since the fluid has mass, it cannot turn a sharp corner except under infinite pressure. When the body has curvature the fluid can follow the curve only provided the pressure at that place is sufficient to overcome the centrifugal force. Experiment shows that discontinuity commences where abrupt changes of form are made, and this discontinuity is unstable, breaking up into eddies.

Figures 7, 8, 9 and 10 show for air and for water, the surface of discontinuity beginning at the edge of a disc normal to a current which at a critical velocity proportional to the kinematic viscosity $\frac{u}{d}$ of the fluid breaks down into eddies. Note that the nature of the flow is identical in water where the wake is made

FIG. 7.—Water, Low Velocity.

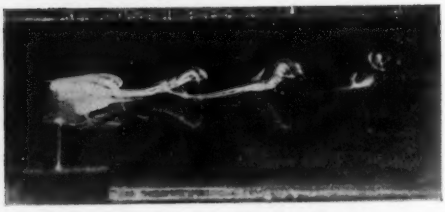


FIG. 8.—Water, High Velocity.

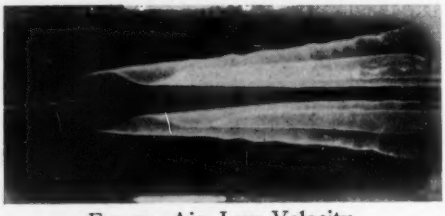


FIG. 9.—Air, Low Velocity.

FIG. 10.—Air, High Velocity.

visible by condensed milk spilling around the edges of the disc and in air where smoke is used for the same purpose.

VORTICES

The surface of discontinuity is the mother of a family of ring vortices which form the wake. The propagation of these vortices is periodic and their kinetic energy represents a loss of energy and a resistance to propulsion. The fact that a vortex represents a definite amount of kinetic energy I can show by an experiment with a smoke box.

The box filled with smoke has a hole in one side. When the box, which is not stiff, is compressed slightly some of the smoke-colored air inside squirts out of the hole. But the hole, not being a turbine nozzle, has a sharp edge producing discontinuity and a

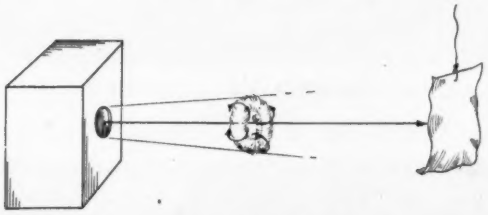


FIG. 11.—Smoke Box. Smoke Ring Strikes Suspended Paper, Bursts and Causes Sharp Reaction of Paper.

vortex. The surface of discontinuity is unstable, but the vortex ring is stable due to its rapid rotation. The vortex ring has a circular core about which the air whirls giving the ring as a whole a velocity of advance corresponding to the direction of the velocity of the air at the center of the ring. The vortex ring includes a mass of air with kinetic energy both of translation and rotation. So long as the air whirls, the ring is stable and acts like a rigid body. The impact of such a smoke colored vortex ring on a suspended sheet of paper indicates by the shock to the paper the fact that the ring is the embodiment of energy.

RESISTANCE

Obviously, then, to design an airship to be easily propelled through air, we must avoid the formation of vortices in the wake. This means avoid any rapid change of curvature which might create an unstable surface of discontinuity.

Fig. 12 shows the enormous wake in the rear of a shape having a sharp change of curvature and Fig. 13 shows how greatly the condition is improved when the deflection of the fluid is more gently accomplished. Note that the fluid follows the contour of the body almost to amidships, but is unable to follow the curve of the side as it closes in to the stern. The after body is too blunt.

The solution of the problem has been found ages ago by the fast swimming fish. The trout has a head approximately parabolic and an almost flat side gradually tapering to the tail. The water presumably follows the contour of a trout's body without serious eddy making. Torpedoes, submarines and airships are fish shaped.

The airship model shows no eddy formation. It is unfortunate that we cannot make our ships and aircraft slippery like a fish to reduce or eliminate skin frictional resistance as well as the density resistance due to eddy making.

BERNOULLI'S EQUATION

Along any stream line, in non-turbulent flow, the pressure p and velocity v are related by Bernoulli's equation, neglecting compressibility:

$$p + \tfrac{1}{2}dv^2 = p_0, \text{ a constant.}$$

The constant p_0 is the total head availab'e, and the equation shows that when the velocity is high the pressure in the stream is low. At a point on the exact nose of an airship, a stream line is brought to rest and $p = p_0$. This is the maximum pressure possible to obtain and for 70 miles per hour is 12.5 lbs. per sq. ft. above atmospheric pressure. As the stream lines bend round the bows, the velocity increases and the pressure decreases so that it is below atmospheric. There is, therefore, a virtual suction over the curved parts of the airship when the velocity is high. The integral of all the suctions and pressures is the net aerodynamic reaction on the body.

Bernoulli's equation is fundamental in hydraulics and ventilation as well as in aerodynamics. It is applied directly in the Pitot and in the Venturi tube for the measurement of velocity. The ancient paradox of the two balls illustrates the reduction of pressure with velocity. If I blow a blast of air between two suspended

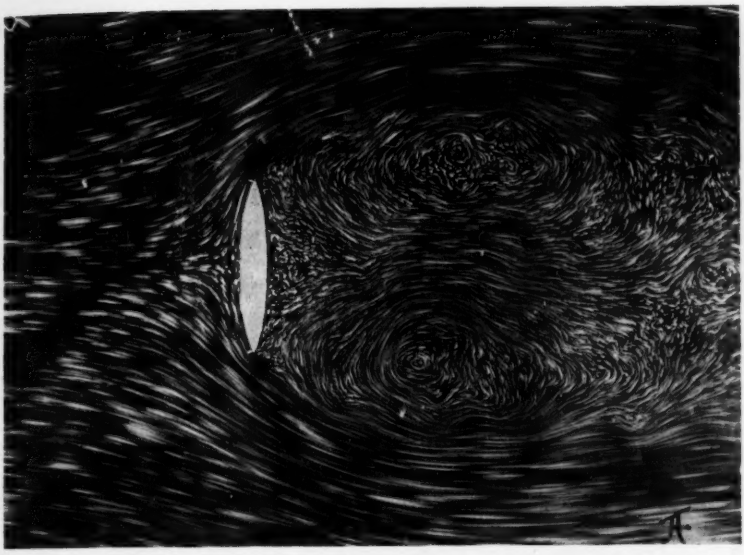


FIG. 12.—Twin Eddies in Wake. Note the Line of Discontinuity Enclosing the Eddies.

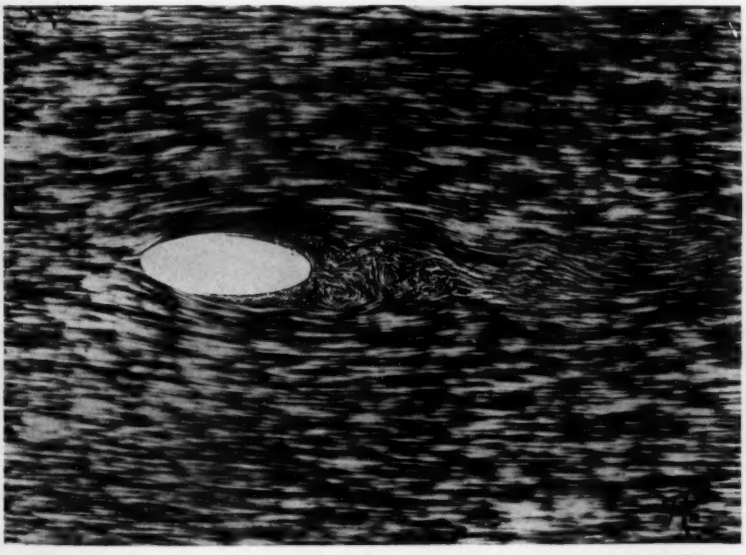


FIG. 13.—An Easier Form. Compare with Fig. 12 and Note the Enormous Decrease in Size of Eddies. True Stream Line Flow Holds Only as Far as Amidships.

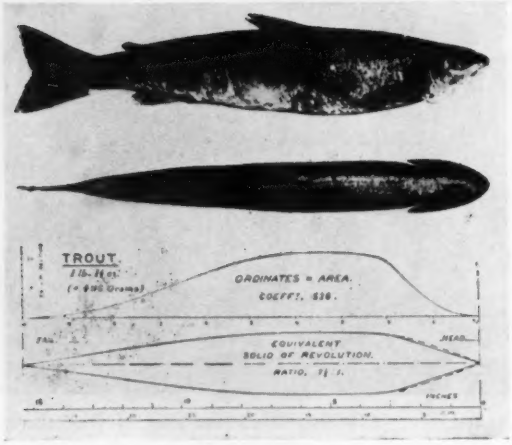


FIG. 14.—Sectional Areas of Trout. (After Lanchester.)

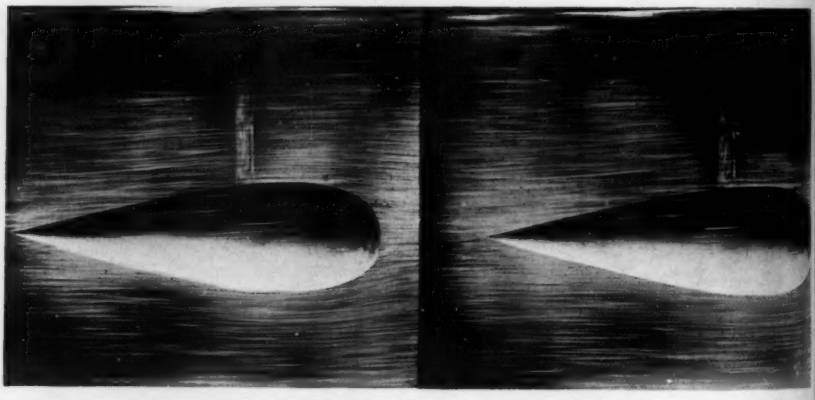


FIG. 15.—Stream Lines Relative to Airship Model. Note Absence of Eddies. (Stereoscopic View after Ahlborn.)

balls *A* and *B* which are about $\frac{1}{4}$ inch apart, the blast of air, instead of blowing the balls apart as might be expected by "common sense," sucks them together until they make rolling contact. The balls rotate under the action of skin friction.

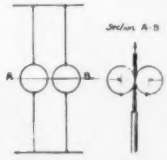


FIG. 16.—Showing How Two Balls Are Sucked Together by a Blast of Air Passing Between Them.

MAGNUS EFFECT

When a base ball is thrown with a spin the air, being viscous, is speeded up on one side and slowed down on the other. As a result there is a decrease of pressure on the side where the relative velocity is higher and the ball tends to curve to that side. A similar explanation holds for the curved flight of golf and tennis balls. The force of the air on a cylinder held in a blast of wind has been found experimentally to be increased fourfold if the cylinder spins at 10,000 revolutions per minute and this force is now inclined 60 degrees to the direction of the wind.

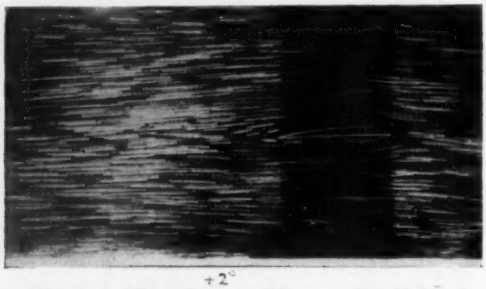
As I throw ping pong balls from a trough lined with sand paper the balls will start off with a spin toward the sand paper side and should curve toward that side in flight. If I am skillful enough, a ball thrown to spin correctly will soar on a rising trajectory. If you tee a golf ball too high and the head of your club passes under the ball you may see such a soaring trajectory.

AERODYNAMIC LIFT

An airplane wing resembles the wing of a bird and is designed to produce a net aerodynamic reaction which shall be in a direction oblique to the wind so as to give a large vertical component or lift for a given horizontal component or resistance. Symmetrical shapes in the wind obviously are subjected to a symmetrical distribution of pressures and suctions giving rise to resistance only.

An airplane wing is cambered upwards and inclined to the wind in such a manner as to present the lower side at a small angle of incidence. As a result of this unsymmetrical presentation the air striking the lower surface is slowed up producing positive pres-

sures over the bottom surface. Likewise, the air following the camber of the top surface is speeded up giving rise to suction over the top. The total lift of the wing is the algebraic sum of these suctions from above and pressures from below. A good airplane wing obtains two-thirds of its lift from suction over the upper surface. The exact curvature of the upper surface is, therefore,



+2°

FIG. 17.—Flow Over a Wing at Small Angle of Incidence. (The Wing is Shown in Section. The Dark Vertical Band is a Shadow.)

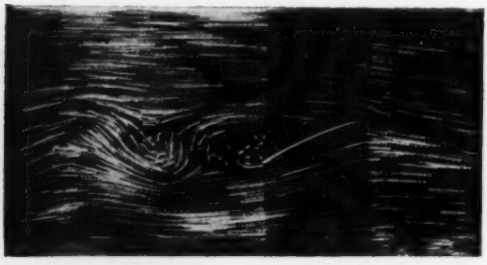


FIG. 18.—Flow Over a Wing at a Large Angle of Incidence. (Flow from Right to Left.)

of more importance than the form of the under surface, which may be flat.

Figure 17 shows an airplane wing at a small angle of incidence. The photograph is made in a water channel and the streaks are the paths of particles of illuminated sawdust during the period of exposure. Note how the streaks are longer above the wing indicating higher velocity. There are no apparent eddies made.

Figure 18 shows the same wing inclined at too great an angle. The lower side is effective in slowing up and deflecting fluid down-

FIG. 19.—Eddy in Wake of Wing. Two Eddies Begin as Small Whirlpools. Flow is from the Left Visible by Condensed Milk in Water.

FIG. 20.—The Eddies of Fig. 19 have Expanded and Been Torn Away. The Direction of Stream Lines is Shown by the Short Bright Streaks.

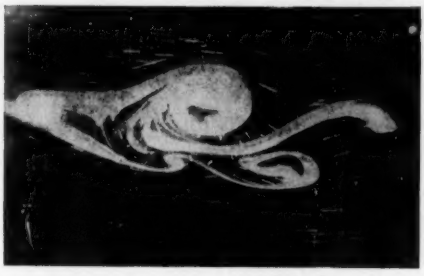


FIG. 21.—The Two Eddies of Fig. 19 Become Detached and the Cycle is Repeated. Note Birth of New Eddy Behind Trailing Edge of Wing.

ward, and this surface is still giving a good lift. But the upper surface is so steeply inclined that the air cannot follow it but breaks away into violent eddies. The density resistance is very great and the wing is said to be stalled or to have reached a "burble point." The ratio of lift to resistance at small angles may be as high as 20 to 1, but at the critical angle this ratio may drop to 3 or 4 to 1. For this reason, airplanes must fly at angles of incidence less than this critical angle which is of the order of 16° for most wings. There is not engine power enough to fly at greater angles and the aeroplane stalls and dives if unluckily the safe limit is exceeded.

The formation of eddies by an airplane wing is a periodic phenomenon identical with the generation of eddies in the wake of any badly shaped body. Figs. 19, 20 and 21 are from a moving picture film taken to show the birth, growth and dissipation of the vortex behind the leading edge and alternately the corresponding but smaller vortex which forms at the surface of discontinuity at the trailing edge. The frequency of this eddy generation is such that dangerous vibrations can be set up in the wings of an airplane if the natural period of the structure happens to be right.

The lift of a wing is given by the pressures and suctions upon it. This is, however, merely the mechanism by which the reaction of the air is transmitted to the wing. Fundamentally, the lift is due to deflecting air downward; imparting downward momentum. If no air is deflected down there is no lift. Ultimately the weight of the airplane is transmitted to the earth, and were we able to measure so slight a disturbance of the barometer, we should find that the pressure is increased when an airplane flies over us.

AIRPLANE EQUILIBRIUM

An airplane in flight is in equilibrium when the aerodynamic reaction is just balanced by the weight of the machine and the thrust of its propeller, while the moments of these forces balance one another. Similarly, when the engine stops, the airplane must glide downward on an inclined path such that the component of gravity balances the resistance. Consider gliding as the simplest case, then Fig. 22 shows the balance of forces. The airplane will glide at an angle whose tangent equals the ratio of lift to resistance and at such a speed that sufficient lift is developed by the wings.

Thus for every angle of glide there is one and only one proper speed. Likewise, since the forces acting must have no moment for a given balance or center of gravity location, there corresponds a particular angle of glide for which the reaction of the air passes through the center of gravity. An actual airplane may glide at different angles and different speeds as the pilot may set his diving rudders or elevators. For every position of the elevators, corresponds one gliding attitude for which the forces are in equilibrium.

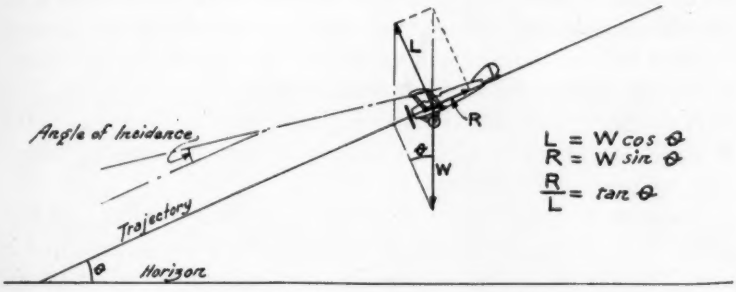


FIG. 22.—Balance of Forces in a Glide.

AIRPLANE CONTROL

In flight an airplane is controlled or steered in three dimensions by means of the ordinary horizontal and vertical rudders of the submarine with the addition of a third control, the ailerons. Ailerons are flaps trailing behind the wing tips, which when turned up or down impress a rolling moment on the airplane. This completes the "three rudder" system of control necessary for controlled motion in three dimensions.

Since control is entirely aerodynamic, it follows that the airplane must preserve its velocity. Loss of normal speed due to any cause is immediately followed by partial or complete loss of control. An airplane must not only keep moving to stay up, but must move at its normal speed in order that control may be maintained.

AIRPLANE STABILITY

The mathematical theory of airplane stability cannot be gone into here, but we can consider something of the general nature of

the problem, at least sufficiently to show that there is a problem essentially aerodynamic in nature.

An airplane is dynamically stable in flight if, when disturbed for any reason from its natural attitude of flight, it tends to return to that attitude without the intervention of the pilot. In other words, its equilibrium is stable.

A stable airplane may go through various oscillations in pitch, roll and yaw while getting back to equilibrium and the pilot by his control may intervene to limit the disturbance. However, if an airplane is too stable its motion may be so vio'ent that the pilot has difficulty in controlling it. It may for example, carry so much weather helm as to make it unhandy for rapid maneuvering. What is desired is some stability but not too much.

A definitely unstable airplane is dangerous, no matter how the controls are operated as such a machine requires constant attention to keep it right side up.

Stability in three dimensions involves motion in pitch, roll and yaw. The motion involving pitching is called longitudinal and is two dimensional. The motion in yaw and roll is called lateral and is more complicated. To observe the general nature of the problem, let us consider only the simple case of the longitudinal motion.

LONGITUDINAL STABILITY

It is evident that for the equilibrium in a given glide to be stable, there must be restoring or righting moments called into play when the airplane pitches. If the airplane wings and tail surfaces are correctly designed, an aerodynamic righting moment can be produced which is in every way analogous to the righting moments acting on a ship when it rolls. This righting moment is characterized by a metacentric height similar to the metacentric height of a ship. For small airplanes to be quickly maneuvered the metacentric height is 3 or 4 ft. For large seaplanes 12 to 20 ft. is usual.

The righting moment is caused by a shift of the line of action of the net aerodynamic reaction on the airplane as shown in Fig. 23. There the vectors represent the total force on a model airplane for different attitudes. Note that if the model stalls or presents its wings at a large angle, the resultant force vector shifts behind the center of gravity and lifts the tail. Similarly, if the model dives, the vector shifts forward and lifts the nose. There is one

stable attitude of equilibrium where the vector passes through the center of gravity.

To arrange the shifting of vectors in such a manner as to give an adequate restoring moment, but not too much, is a matter of design and involves many factors but principally the size and position of the horizontal tail surface or "stabilizer." The latter in accordance with Penaud's principle is inclined slightly upward.

Stability depends on the shifting of vectors relative to the center of gravity. It is of extreme importance to locate the center of gravity correctly. If too far back the vectors do not pass in rear of it until the airplane has already stalled and lost speed. The righting moment will then throw the airplane into a steep dive to

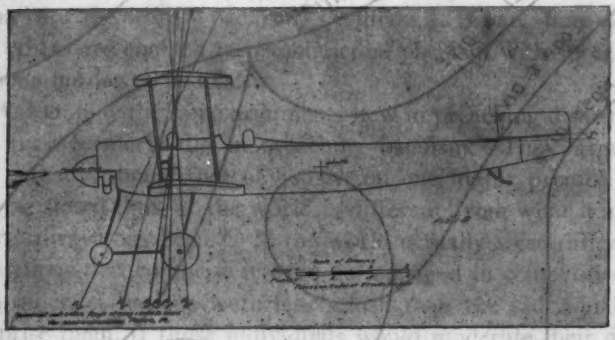


FIG. 23.—Vectors Representing Total Air Force at Different Angles of Incidence.

pick up speed. Such a machine, while stable, is very dangerous as it is likely to stall at a low altitude and then dive into the sea in spite of the pilot's efforts. Its natural path in space will look like a section of the Rocky Mountains.

Similarly, if the airplane is balanced too far forward, other troubles are introduced.

A righting moment implies, oscillations or hunting about the attitude of equilibrium. The inherently stable airplane may overcorrect itself. To quench such oscillations it is necessary to provide damping surface on the tail. It is possible to arrange matters so that only a gentle undulation will remain.

This pitching motion of a plane is called the phugoid oscillation, and Lanchester has shown that depending on the balance and aero-

dynamic features, an airplane can take one of the paths in space shown in Fig. 24.

The series of paper airplane models which my assistant will launch from the gallery will exhibit these various types of motion.

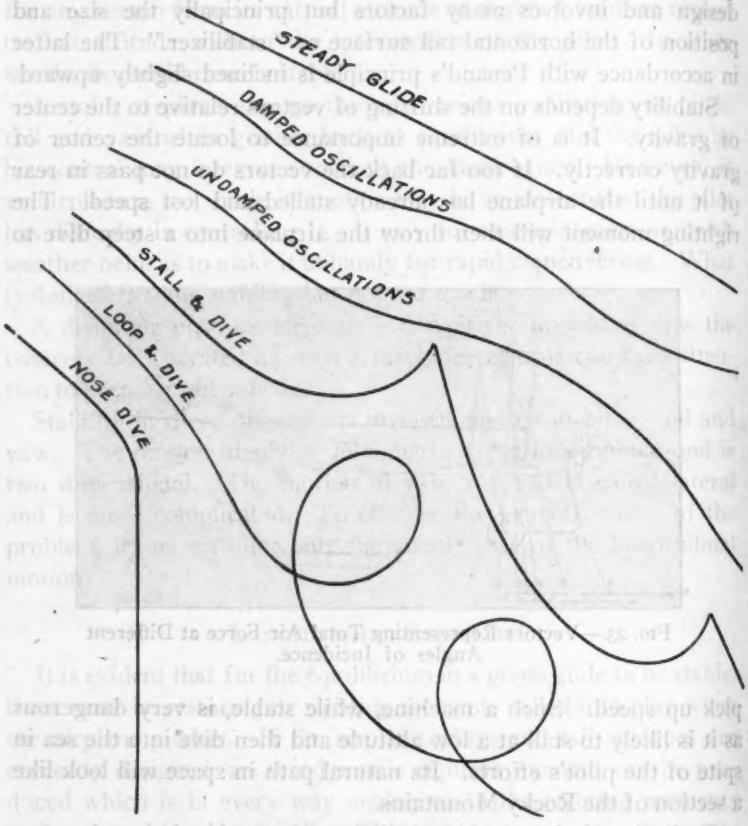


FIG. 24.—Various Possible Trajectories for a Gliding Airplane Depending on Balance and Stability.

The models are all identical but the center of gravity of each has been so adjusted by means of a small weight that the model will glide in accordance with one of the flight paths shown.

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DISARMAMENT AND FOREIGN TRADE

By REAR ADMIRAL BRADLEY A. FISKE, U. S. Navy (Retired)

P. T. Barnum declared "the public like to be humbugged." This seems to be true; for, by merely substituting the word "disarmament" for the word "pacifism," William J. Bryan, Jane Addams and others are enabled to preach actual pacifism with success, and humbug hordes of people.

They employ the same arguments now in preaching disarmament that they formerly did in preaching pacifism. Their arguments rest actually, though not obviously, on one major premise which may be stated thus—"the world is different from what it actually is and always has been." If the world actually were different, if the nations that comprise it were not engaged in competition with each other, if nations were less selfish than the individuals who comprise them, if those individuals would moderate their desires, or if they could be made to moderate them by other means than force, then the pacifists, or disarmamentists, would be right.

But what kind of a world is this? What does the record of men's activities for more than 5000 years tell us? The most obvious fact is that men have produced a wonderful civilization.

But what is it that has spurred men to exert themselves to achieve this civilization? Obviously, the spur has been the necessity imposed on the individual men to "make a living"; for, except in the warm and moist countries of the tropics where little civilization has been achieved, men have had to work in order to obtain food, shelter and clothing. Unfortunately, some men have been able to get more than others. From this cause, fights have arisen throughout the life of the human race: men have fought for what they wanted, during hundreds of thousands of years; just as now two dogs will fight for a bone.

Now one of the most significant facts of history (and of daily experience) is that men and nations rarely fight merely to fight,

even if they seem to do so. Fighting is an exceedingly tiresome and exceedingly dangerous activity; and people do not resort to it without great cause. The usual cause is a desire to get something, or to keep something that some one else is trying to get. Sometimes, the immediate cause is anger: but that anger has usually been caused by an attack made to get some money, land or other possession. Sometimes, the possession is an immaterial one, such as reputation.

The expression "self-preservation" is usually supposed to mean preservation of one's actual life. But the instinct to preserve our lives carries with it the instinct to surround ourselves with all the safeguards possible, and to make our lives as comfortable and happy as we can. These ends are best served (in the eyes of most people) by "making money"; because money is the best single medium of exchange, and is more accurately standardized than any other of the material and immaterial objects that men strive for. As there are not enough of material and immaterial things to satisfy everybody, there is tremendous competition to get them. Wherever there is competition, there is apt to be strife; and wherever there is strife, there is apt to be fighting of some kind. Back of every fight, there can usually be found competition for some thing.

It is a commonplace remark that nations behave like individuals. It is a fact, but the fact is continually forgotten. If it were not forgotten, we should not hear foreign trade and disarmament advocated by the same people; because armament is the only means by which a nation can guard its foreign trade. The misleading expression "International Law" makes most people forget that no law exists among nations which can control their relations with each other; and it causes many of those wholly wrong conceptions of international affairs that the disarmamentists spread. Let us not forget for an instant that there is no law in existence that controls, or pretends to control, any nation in its dealings with any other. Every nation is an absolutely independent organization, owing allegiance to nobody but itself.

It will help us to clear our mental view, if we visualize nations as actual individuals, engaged in continuous competition with each other, without any enforceable law regulating their conduct; just as jealous of each other as the bitterest individual competitors in trade, just as willing to enter into agreements which promise

advantage to themselves, just as shrewd, and just as willing to violate those agreements, when opportunity offers an advantage for so doing. Imagine a city without any enforceable law compelling its merchants to carry out their agreements!

Now no organization capable of enforcing law has ever existed, except a tribe or a nation; and a tribe or a nation can enforce law within itself only. For this reason, no organization that could secure world peace has ever existed, except a world-dominating nation. The Egyptian, Assyrian, Babylonian, Persian, Macedonian and Roman empires were such organizations, and maintained peace for long intervals over the then known world. To that kind of peace, the name *Pax Romana* has been given. It was maintained by armament; and, so far as the experience of mankind during 5000 years of recorded history can teach us, *armament is the only agency that can maintain even the approximate state of peace that the world has enjoyed in modern times.*

Let us laud trade frankly for the benefit it has wrought; but let us realize, at the same time, that the efforts made by traders have not been wholly unselfish. The beautiful white sails of the Phoenicians must have made stirring pictures, as the vessels that bore them flew over the bright blue waters of the Mediterranean, and threw the salt spray over their bows; but the men who spread those sails did so mainly to "make money," wherewith to live and to let their families live. Furthermore, the people who bought the wares that the Phoenicians brought did not buy them in order to help the traders to make money. They bought them to satisfy their own desires.

This brings us to the crux of the whole matter; for, while it is the struggles of men and nations to make money (or its equivalent) that constitute the immediate cause of war, it is the desires of people to secure the things which only money can secure, that causes those struggles to make money. *Therefore, it is the desires of people for the things that money buys that constitute the bottom cause of war.*

It seems plain, however, that (at least in modern times) it is not the desire of people for mere food, or mere shelter, or mere clothing that causes wars; because these things are not hard to get. At least, they would not be hard to get, if people wanted nothing else, and concentrated their efforts on getting them. In this case, people would have little reason to live any but an agri-

cultural life, spread evenly over the land; few causes of strife would arise, and actually no wars, in the modern meaning of that word. It is the desires of people for fine apparel, for sumptuous houses, for the fruits and the products of foreign lands—for luxury, in a word—that sends ships over the seas, that compels men to work in mines and factories, that causes great cities to be built, that induces people to live among surroundings that are artificial, that creates appetities that are artificial, that makes many a man a mere getter of money.

It has finally produced a Machine of Civilization so complex that not one man in the world can understand it all. This machine is now going at a speed that seems to be increasing and to be going to increase; with no goal in sight, and with so many causes of derangement present, as to suggest the possibility of an accident some day. The Fall of Rome is an example of a complete smash up of a machine of civilization; and the present condition of Russia supplies a similar example, though in a less degree. Both show that *a state of civilization is not necessarily a stable or permanent condition.*

In such a chaotic state of affairs as exists at present, any advocacy of disarmament, even partial disarmament, seems, to say the least, inopportune. Disarmament cannot possibly lessen the chance of war, and the need seems obvious for more strength in each nation and not less. Nations, fundamentally, fight to get what their men and women want; no matter whether they be savages who use clubs, or highly civilized Christians who use airplanes. The cause of nations fighting is not the weapons that they fight with, but the desires that they fight to gratify.

Many of those who are calling loudly for disarmament are also calling loudly for increasing foreign trade. Clearly, the projects are incompatible.

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PROBABILITY AND ACCURACY OF GUN FIRE

By Lieut. Commander T. C. Kinkaid, U. S. Navy

The laws of probability and chance, as expounded in a treatise on mathematics, are based upon conditions which never actually obtain in connection with gun fire on board ship but, nevertheless, these laws have a definite bearing on salvo dispersion and it is essential that the officer controlling a battery firing at long range have a detailed knowledge of these laws and appreciate the effect of natural dispersion on the spread of salvos.

If it were possible to construct a perfectly designed gun, firing perfect ammunition, controlled by perfect equipment, and to eliminate the atmospheric and other outside influences on the flight of projectiles, the laws of probability and chance would play little part in practical gunnery. Successive shots from such equipment would fall in the same place and gunnery would be reduced to an exact science.

This is not the case, however. Perfect equipment cannot be made, and successive shots fired from the same gun at the Naval Proving Grounds under the most nearly similar conditions that can be produced do not fall in the same place but are seen to move, both in range and deflection, forming a pattern, the size of which depends upon the design of gun and projectile, the consistency of the propellant charge and the variation in atmospheric effect upon the flight of the projectile. If a great number of shots are fired, under as nearly as possible the same circumstances, it will be found that the impacts are grouped closely together around one point and are more and more widely separated as the distance from that point increases.

The point about which the impacts are grouped is called the *mean point of impact* and its co-ordinates are the average co-ordinates of all the impacts. The deviations of projectiles from their mean point of impact are closely analogous to what are called

"accidental errors" and they obey the same laws. Small deviations are more frequent than large ones; positive and negative deviations are equally probable, and are therefore equally frequent if the number of shots is great; very large deviations are not to be expected at all and when one occurs it is frequently due to some avoidable mistake. The average of the deviations from the M. P. I. of a large number of impacts is called the *true mean error* of the gun.

In practical gunnery, we are interested only in the effect of these deviations on the dispersion of shots in a salvo and in the variations which occur in the mean points of impact of successive salvos. When we consider the deviation of projectiles we are not dealing with definite numbers (as in dice throwing), but with values which may be anything whatever between certain limits and we cannot assign any finite measure to the probability that a deviation shall have a definite value because the number of values it may have is unlimited. We can, however, measure the probability that a deviation will fall between certain limits or that it will be greater, or less, than an assigned quantity.

If a large number of shots (y) are fired under the same circumstances and (m) shots are observed to fall 100 yards from the M. P. I., while the remainder ($y-m$) fall more than 100 yards from that point, we say that the probability that a shot will fall within 100 yards of the M. P. I. is $\frac{m}{y}$ and the probability that a shot will be more than 100 yards away is $\frac{y-m}{y}$. The probability that a shot will be less than 100 yards or more than 100 yards from the M. P. I. is $\frac{m}{y}+\frac{y-m}{y}=1$; that is, it is a certainty.

The probability curve is plotted with distances from the M. P. I. as abscissæ and the numbers of shots within those distances as ordinates, and, when the total number of shots is infinite, may be considered to consist of an infinite number of rectangles whose width is reduced to the infinitesimal dz. The width of each rectangle becomes the elementary area ydz and the whole area under the cure is $\int_{-z_1}^{+z_1} ydz$. The area under the curve between any two co-ordinates divided by the whole area measures the

probability that a deviation will be between those co-ordinates. The curve takes the form

$$y = \frac{1}{\pi D} \epsilon^{-\frac{x^2}{\pi D^2}},$$

where D = true mean error, $\pi = 3.14159$, $\epsilon = 2.71828$ and the factor $\frac{1}{\pi D}$ has been introduced to make the whole area under the curve equal to unity,

$$\int_{-\infty}^{+\infty} \epsilon^{-\frac{x^2}{\pi D^2}} dx = \pi D,$$

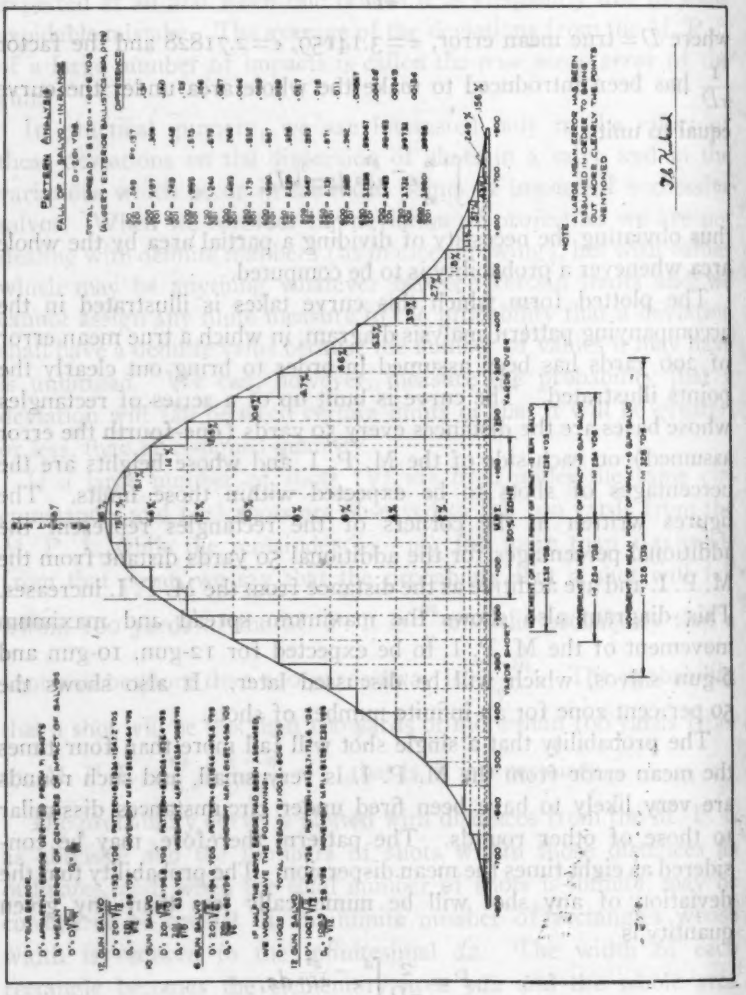
thus obviating the necessity of dividing a partial area by the whole area whenever a probability is to be computed.

The plotted form which this curve takes is illustrated in the accompanying pattern analysis diagram, in which a true mean error of 200 yards has been assumed in order to bring out clearly the points illustrated. The curve is built up of a series of rectangles whose bases are the distances every 50 yards (one-fourth the error assumed) on each side of the M. P. I. and whose heights are the percentages of shots to be expected within those limits. The figures written in the corners of the rectangles represent the additional percentages for the additional 50 yards distant from the M. P. I. and are additive as the distance from the M. P. I. increases. This diagram also shows the maximum spread and maximum movement of the M. P. I. to be expected for 12-gun, 10-gun and 6-gun salvos, which will be discussed later. It also shows the 50 per cent zone for an infinite number of shots.

The probability that a single shot will fall more than four times the mean error from the M. P. I. is very small, and such rounds are very likely to have been fired under circumstances dissimilar to those of other rounds. The pattern, therefore, may be considered as eight times the mean dispersion. The probability that the deviation of any shot will be numerically less than any given quantity is

$$P = \frac{2}{\pi D} \int_0^a \epsilon^{-\frac{x^2}{\pi D^2}} dx,$$

where a is the limiting distance from the M. P. I. Values of P, with the ratio $\frac{a}{D}$ as the argument, have been calculated and tabulated in Alger as follows, so that it is only necessary to know the



mean dispersion to pick out the probability of a single shot falling within certain limits.

PROBABILITY OF A DEVIATION LESS THAN a IN TERMS OF THE RATIO $\frac{a}{D}$

$\frac{a}{D}$	P	$\frac{a}{D}$	P	$\frac{a}{D}$	P	$\frac{a}{D}$	P
0.1	.064	1.1	.620	2.1	.906	3.1	.987
0.2	.127	1.2	.662	2.2	.921	3.2	.990
0.3	.189	1.3	.700	2.3	.934	3.3	.992
0.4	.250	1.4	.735	2.4	.945	3.4	.994
0.5	.310	1.5	.768	2.5	.954	3.5	.995
0.6	.368	1.6	.798	2.6	.962	3.6	.996
0.7	.424	1.7	.825	2.7	.969	3.7	.997
0.8	.477	1.8	.849	2.8	.974	3.8	.998
0.9	.527	1.9	.870	2.9	.979	3.9	.998
1.0	.575	2.0	.889	3.0	.983	4.0	.999

As an illustration of the use of this table, taking $a=200$ yards and $D=100$ yards, we find that for $\frac{a}{D}=\frac{200}{100}=2$, $P=.889$; that is, for a gun whose mean error is 100 yards the probability of a single shot falling within 200 yards of the M. P. I. is .889. If P is the probability that the deviation of a single shot will not be greater than a, then evidently $100P$ will be the probable number of shots out of 100 which will fall within the limits $\pm a$; in other words, $100P$ is the percentage of hits to be expected in an area $2a$ wide with its center at the M. P. I. Thus, we see that the area in which 25 per cent of all shots may be expected to fall is $\pm .4D$; the 50 per cent zone is $\pm .846D$; the 75 per cent zone is $\pm 1.445D$. The half-width of the 50 per cent zone, $.846D$, is the probable deviation since it is the deviation which is just as likely to be exceeded as it is not to be exceeded.

If the M. P. I. falls a distance d from the center of the danger space of a target whose danger space is equal to S, then the percentage of hits to be expected from an infinite number of shots is:

$$\%\text{ hits}=100\times\tfrac{1}{2}\left[P_1\left(\text{for }\frac{a}{D}=\frac{d+\frac{S}{2}}{D}\right)-P_2\left(\text{for }\frac{a}{D}=\frac{d-\frac{S}{2}}{D}\right)\right].$$

Thus, if $d=200$ yards, $S=100$ yards and $D=100$ yards, we have

$$\frac{d+\frac{S}{2}}{D}=\frac{250}{100}=2.5=\frac{a}{D}\ \therefore P_1=.954$$

$$\frac{d-\frac{S}{2}}{D}=\frac{150}{100}=1.5=\frac{a}{D}\ \therefore P_2=.768$$

$$\therefore \%\text{ hits}=100\times\tfrac{1}{2}(.954-.768)$$

$$=\frac{100\times.186}{2}=9.3\text{ per cent}$$

on a target whose danger space is 100 yards, if the M. P. I. falls 200 yards from the center of the danger space, the mean error of the gun being considered to be 100 yards. The same percentage of hits would be made whether the M. P. I. fell over or short.

The following table shows the percentage of hits to be expected, on a target whose danger space is 100 yards, from a gun whose true mean error is 100 yards for different locations of the M. P. I.:

PER CENT HITS FOR DIFFERENT LOCATIONS OF M. P. I. RELATIVE TO THE TARGET

d	Per cent hits
0	31.0
50	28.8
100	22.9
150	15.7
200	9.3
250	4.7
300	2.05
350	.8
400	....

Formula

Per cent hits

$$=100\times\tfrac{1}{2}\left[P_1\left(\text{for }\frac{a}{D}=\frac{d+\frac{S}{2}}{D}\right)-P_2\left(\text{for }\frac{a}{D}=\frac{d-\frac{S}{2}}{D}\right)\right]$$

S = danger space = 100 yards.
D = true mean error of gun = 100 yards.
d = distance of M. P. I. from center of danger space.
P_1, P_2 = probability of shots falling within limits given.

It will be noted that the percentage of hits decreases rapidly as the M. P. I. is moved away from the center of the danger space. This reduction takes place more rapidly in the case of a pattern resulting from a small mean error than in the case of a pattern due to a large mean error. The following table shows the percentages of hits to be expected on a 100-yard danger space from an *infinite* number of shots fired from guns having mean errors of from 50 yards to 250 yards where the M. P. I.'s are various distances from the center of the danger space. If the fire cannot be regulated to bring the M. P. I. on the center of the danger space, it may be detrimental to have too small a mean error. From examination of the table we find that, if the M. P. I. is 50 yards from the center

of the danger space, a gun with a 50-yard mean error should get about twice as many hits as a gun with a mean error of 150 yards. If, however, the regulation of fire brings the M. P. I. within only 200 yards of the center of the danger space, the gun with a 50-yard error gets practically no hits, while the gun having a mean error of 150 yards should get about 12 per cent hits. The most efficient mean error, and therefore pattern, is directly dependent upon the ability to control the fire; that is, upon the relative positions of the M. P. I. and the center of the danger space of the target.

TABLE OF HITS FOR DIFFERENT MEAN ERRORS AND DIFFERENT POSITIONS OF THE M. P. I.

d yards	Per cent hits on 100 yard danger space				
	D=50 yards	D=100 yards	D=150 yards	D=200 yards	D=250 yards
0	57.5	31.0	20.9	15.8	12.7
50	44.5	28.8	20.3	15.5	12.5
100	20.4	22.9	18.3	14.6	12.1
150	5.5	15.7	15.3	13.3	11.4
200	.9	9.3	12.1	11.6	10.4
250	....	4.7	8.9	9.7	9.3
300	....	2.1	6.1	7.8	8.0
350	....	.8	3.9	6.1	6.8
400	....	.25	3.1	4.6	5.7
450	....	....	1.3	3.3	4.6
500	....	....	.7	2.2	3.6

d = distance of M. P. I. from center of danger space.

Heretofore, we have considered only shots fired from a single gun. If several shots could be fired at the same time from one gun, or if a salvo is fired from several exactly similar guns, the spread of the salvo, or the pattern, will have a certain relation to the number of shots in the salvo and to the mean error of the gun. The probability that a 12-gun salvo will make as large a pattern as an infinite number of shots is very small. The probable salvo limits are the limits outside of which no shot will probably fall. If the total probability *outside* of such limits is therefore unity, or less, it must be $\frac{1}{n}$ for each of n shots in a salvo. The probability of falling *within* these limits is therefore

$$P = \frac{n-1}{n}.$$

and for a 12-gun salvo, we have

$$P=\frac{n-1}{n}=\frac{11}{12}=.917$$

$\therefore$ from the table $\frac{a}{D}=2.17$ (corresponding to $P=.917$)

$$a=2.17D=217 \text{ yards},$$

the total spread $=2a=434$ yards which is the *average* spread to be expected for 12-gun salvos fired from a gun whose true mean error is 100 yards.

The apparent mean error for n shots is

$$D_1=D\sqrt{\frac{n-1}{n}},$$

and for a 12-gun salvo, we have

$$D_1=100\sqrt{\frac{11}{12}}=95.7 \text{ yards}.$$

The *maximum* pattern to be expected for a 12-gun salvo is

$$8D_1=8\times 95.7=765.6 \text{ yards},$$

and all 12-gun salvos should come within this limit.

If only a few shots are fired in a salvo, the M. P. I. of those shots does not necessarily coincide with the M. P. I. of an infinite number of shots and the M. P. I.'s of successive salvos would shift back and forth. The greater the number of shots in a salvo, the more nearly we may expect the M. P. I. of the salvo to coincide with the M. P. I. of an infinite number of shots. The error of the M. P. I. of a salvo varies inversely as the square root of the number of shots in the salvo and we have

$$D_0=\frac{D}{\sqrt{n}}$$

where D_0 is the mean error of the M. P. I. of the salvo. For a 12-gun salvo

$$D_0=\frac{100}{\sqrt{12}}=29 \text{ yds}.$$

The maximum movement of the M. P. I. for successive salvos is

$$8D_0=232 \text{ yards};$$

that is, the M. P. I. of a 12-gun salvo may have an error of (+) or (−) 116 yards from the M. P. I. of an infinite number of shots. The average movement should be about (+) or (−) 63 yards.

The following table shows the patterns and movements of M. P. I. to be expected when salvos containing various numbers of shots are fired:

TABLE OF PATTERN SIZES AND MOVEMENTS OF M. P. I.
$D = 100$ Yards

1	2	3	4	5	6
No. shots	Apparent mean error $=D_1$	Maximum pattern to be expected	Average pattern in terms of D	Average pattern in yards.	Mean error of M. P. I. in terms of D	Max. *movement* of M. P. I.
1	....	....	....	....	1.00	800
2	70.7	565.6	1.69	169	.71	568
3	81.6	652.8	2.43	243	.58	464
4	86.6	692.8	2.89	289	.50	400
5	89.4	715.2	3.21	321	.45	360
6	91.3	730.4	3.47	347	.41	328
7	92.6	740.8	3.67	367	.38	304
8	93.5	748.0	3.85	385	.35	280
9	94.3	754.4	3.99	399	.33	264
10	94.9	759.2	4.13	413	.32	256
11	95.3	762.4	4.24	424	.40	240
12	95.7	765.6	4.35	435	.29	232
100	99.5	796.0	6.40	640	.10	80
1,000	99.9	799.2	8.00	800	.03	24

NOTES: Column 1: $D_1 = D\sqrt{\frac{n-1}{n}}$; figures are rough.

Column 2: 8 times Column 1.

Column 3: Twice the value of $\frac{a}{D}$ corresponding to $P = \frac{n-1}{n}$ in table; considering the probability of going outside of limits as unity.

Column 4: D times Column 2.

Column 5: $D_0 = \frac{D}{\sqrt{n}}$.

Column 6: $8D_0$ (8 times Column $5 \times D$); the maximum *error* is one-half of the figure in this column $(+)$ or $(-)$.

The application of the foregoing theory to the firing of a battleship at sea is rather difficult and we are reduced to considering probabilities. The main battery of a dreadnought consists of from 8 to 12 different guns, in as many different mounts, in from 4 to 6 double or triple turrets with as many different foundations, and the whole structure of the ship is subject to hogging, and bending,

so that the shots are not fired under "similar circumstances." Also errors are introduced due to the oscillation of the guns about the center of gravity of the ship in rolling and pitching; sight setting, gun laying, ramming of projectiles, different temperatures of powder, different resistances in firing circuits and differences in bore-sighting all produce errors; and, finally, the errors of spotting and fire control take the M. P. I. off of the target. In addition, we should not forget that the number of shots fired is comparatively small and our reasoning must be based on the expected performance for only a few shots, not on the exact figures of the laws of probability and chance which are based on an infinite number of exactly similar rounds.

When a 12-gun salvo is fired from a ship, we know (assuming a mean error of 100 yards for the gun) that the maximum pattern to be expected from gun errors alone is 766 yards and the average 12-gun pattern should be 435 yards if no preventable errors (as distinguished from accidental errors) are present. If the spread of the salvo is 1000 yards, at least 234 yards (1000−766) and probably more of this spread is due to what we have called preventable errors and, if a large number of such salvos were considered, we would expect that 565 yards of this error was due to that cause, only 435 yards being due to accidental errors. We further find from the table that accidental errors may cause the M. P. I. of successive 12-gun salvos to move as much as 232 yards (±116 yards). Any movement greater than this is surely due to preventable errors, while a portion of this movement, the exact amount of which is indeterminate, may also be due to that cause.

A thorough understanding of the above probabilities and possibilities will be of great assistance to an officer controlling the fire of a battery. He should know the true mean error of his guns and from this can calculate the spread and movement of M. P. I. of salvos to be expected from accidental errors. He will have, from previous firings, data which will enable him to make a comparison between the theoretical spread and movement of M. P. I. and the spread and movement of M. P. I. actually obtained in firing. It is believed that such an examination will reveal the fact that preventable errors cause as much, or slightly more, spread and movement of M. P. I. as is caused by accidental errors. The information gathered from such an analysis, combined with observation of the fall of shots, will enable the control officer to correct the range in a systematic manner which is in accord with the laws governing the probability of gun fire.

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A COMBINED STAFF

By CAPTAIN J. M. SCAMMELL, Inf. R. C., U. S. Army

Due to the national situation in the United States, geographical and general, and to national policy, future wars of the United States must be expected to include operations overseas, both of attack and defense, which will require active coöperation and will be more or less successful as that coöperation is more or less complete.

This quotation is taken from an address delivered before the Army War College in 1907 by Admiral (then Commander) H. S. Knapp, U. S. N. Since that time our military and naval operations in the World War have conformed to the above prediction.

Victory crowned our arms; while the coöperation between General Pershing and Admiral Sims was more than harmonious—even cordial—a study of the evidence submitted before the Senate Investigating Committee proves that the absence of a common doctrine did much to weaken the effect of our participation, and that thereby the war was prolonged and treasure and lives uselessly expended. Thus the record of the Hearings of the Senate Committee enables us to verify the second part of Admiral Knapp's prediction.

Had we, instead of having Allies to establish for us our bridgeheads, had to force for ourselves a landing and to have protected our own communications, as the British were forced to do at Gallipoli, this absence of a common doctrine and of a common plan would probably have had equally disastrous consequences. To-day, considering the military weakness of Mexico, and not only the historic good feeling that has endured upon our northern frontier, but also the prevalence of a mutual conviction and determination that this cordiality must and shall continue to exist, the statement of Admiral Knapp takes on an even more intense form. We may accept as an axiom that all our future wars must be

combined overseas operations. And yet practically nothing has been done to define the relationship that should exist between the army and the navy in the problems of strategy, logistics, command and tactics involved in overseas operations.

Of this coöperation, in the same address above alluded to, Admiral Knapp said:

> Neither the army nor the navy is self-sufficient, but each is the complement of the other in the national defense, and consequently coöperation, potential or actual, is always necessary.

This problem of coöperation has been solved in various times by various peoples in various ways. In antiquity there existed no distinction between military and naval command. Soldiers embarked upon ships and became sailors and marines. Brasidas was equally at home upon the quarterdeck of a trireme or upon the quarterdeck of a horse. Cæsar, better than any other, embodies the normal Roman conception of command in war; he was neither a general nor an admiral, but a Roman Governor given military powers which he exercised brilliantly against the enemies of the republic when they made war on land, and with equal brilliance against them on sea if they took to salt water. Even as late as the time of Cromwell, generals commanded fleets as well as armies, and Blake was "A sort of a bloomin' cosmopolouse—soldier an' sailor too."

To-day the rule of all the powers, save the warlike but unmilitary Anglo-Saxons, is that expressed by General von Janson: "One man should be in command, naturally the senior officer."

This was also the rule in Great Britain until the royal power was broken. The English "Fear and dread of Kings" led to a deep suspicion of the military as a bulwark of tyranny—so deep that even to-day it is used as a bobbly-jock in Parliament and Congress alike to hush the crying public: "The goblin of militarism will get you if you don't watch out." Of course it was the mercenary soldiery, and foreign mercenaries at that, which threatened the liberties of our fathers; de Vigny has shown how absurd it is to fear that an army which is the citizens can overthrow their own liberties, and yet of all the powers, we alone, the English and the Americans, do voluntarily retain the professional army. Thus it is purely because of historical influence, because originally it was desired to weaken the coöperation of the two services for political reasons, that to-day we retain the weakest type of command.

The disadvantages of this divided command are and have been acknowledged, studies have been made of how to minimize them and the first steps have been taken to overcome them.

Admiral McCully stated to the Naval War College in 1911:

> When the two services have a clear understanding of each other's point of view, much will have been accomplished, but even then it will be only by mutual and unselfish concessions that fortunate results may be anticipated." . . . .

And that:

> Coöperation between naval and military men . . . . can only be attained through decisions arrived at during peace, free from the friction and irritation that might ensue if required in the stress of an emergency, when action may be imperative.

Admiral Knapp expressed his conclusion that:

> Coöperation has its foundation head at the seat of government, where operations will usually be planned and ordered. From there the spirit of coöperation should extend throughout the services to the last private and landsman.

It is doubtful in the extreme if there can be found any soldier or sailor who will deny the truth of any of the above statements. And yet to-day the number of those in either service who have had the opportunity or the leisure to study the problems of the other is small, and above all, there is no guarantee that any of these favored few will be those chosen for the supreme command when war is upon us.

A solution of these difficulties was proposed by Major W. W. Harts, U. S. M. C., in a lecture before the Naval War College in 1912. It included five points as follows:

> I. Regulations should be adopted, perhaps by a joint board, as extensive as practicable, to be embodied in the official books of regulations of the army and navy, which will expressly outline the duties of each branch of the country's military forces and limit its sphere of action and authority in all joint operations whenever differences in jurisdiction are likely to arise.
>
> II. Combined maneuvers involving embarkation and debarkation should be as frequent as practicable and the regulations above mentioned vitalized periodically by the results.
>
> III. Provisions should be made for exchanging officers in time of war so that in all joint operations a selected officer of the navy should be found on the staff of the commanding general and similarly a representative of the army would be attached to the staff of the naval commander-in-chief.

IV. A standardization is desirable between the two services whenever practicable, including organization, ceremonies, badges, signals and equipments.

V. Several officers should be exchanged in times of peace in maneuvers, war college conferences and target practice. All subjects of defense involving both services should be examined by joint boards.

The interesting phase of the above proposals, as well as those of other writers, is that they implied but did not expressly advocate the organization which alone could have the influence and the authority to bring these consummations to pass. Major Robert E. Wyllie, C. A. C., in an address on "Coöperation between Army and Navy," in 1916, carried his arguments to their ultimate conclusion:

"In times of war," he said, "or of maneuvers, in all joint operations, the interchange of staff officers, and of observers, will be invaluable, and *all such operations should be planned and controlled by a combined General Staff.*"

The same year a committee met at the Naval War College by direction of the President of the College, Rear Admiral Austin M. Knight, to consider the subject of coöperation between the army and the navy. The committee was composed of the following officers:

Captain C. S. Williams, U. S. Navy.
Colonel J. W. Ruckman, C. A. C., U. S. Army.
Commander C. T. Vogelgesang, U. S. Navy.
Major G. C. Thorpe, U. S. M. C.
Lieut. Colonel John P. Haines, C. A. C., U. S. Army.

The first three signed the majority report. The last two signed minority reports which, "agree to all essential points of the report except that both favor placing the Coast Artillery under the Navy Department." Therefore we are justified in concluding that the following extract represents the unanimous opinion of the above committee:

2. The Ideal Organization to Secure Coöperation

It is an axiom of war that all operations of forces, both naval and military, should be confined within the frame of a joint plan of operations, well conceived and definite in its scope. This of course implies a control higher than that of the individual commander of the naval forces and the commander of the military forces—a control properly vested in a great general staff composed of officers of both services and acting as advisers to the highest executive authority of the nation.

It is therefore the mission of a great General Staff in effect to direct the operations ashore and afloat. Such staff should therefore properly be composed of officers of the army and navy—the officers for this purpose must therefore be most carefully chosen. The most competent and intelligent naval officer will not properly fill his place on such a staff unless he is familiar with the conceptions of warfare on land, nor would the most competent and intelligent army officer properly fill his place on such a staff unless he were familiar with conceptions of warfare on the sea.

This report was approved by Admiral Knight on July 6, 1916, and by naval operations on November 23 of the same year.

This is the proposal which has been since put forth in England,[1] and which was referred by Lloyd George to the Imperial Conference.[2] It is a proposal which the organization of the Royal Air Force into a separate third service in the British Empire makes still more urgent. The awkward features of fighting two separate campaigns in the same theater of operations as disclosed by the Dardanelles Report, serves to indicate how still more embarassing three separate campaigns might be.

Such a combined staff, the original plan of organization carefully worked out but regarded as provisional and to be modified through the lessons of experience, would be a powerful asset in many ways.

In the first place there would be gathered together officers capable of determining the proper relations between military and naval aviation; there would be found officers capable of determining such vexed problems as the relative value of battleships, torpedo-planes and submarines; and there would exist a body able to determine and initiate a common doctrine.

There an historical section could compile and classify, and a planning section utilize, the facts of history which would lead to a book of regulations laying down the tactical principals to be followed by each service in landing operations. A combined staff would give a simple organization rather than the present clumsy, expensive and inefficient machinery for ordering combined maneuvers to test and try out these regulations. Such a body could with equal ease and equal certainty prescribe the liaison officers to be

[1] "Imperial Strategy and a Combined General Staff," by Lieut. Col. J. C. Dundas, D. S. O., R. A., General Staff, in *The Journal of the Royal United Service Institution*, November, 1920.

"Defense of the British Empire," by Major General Sir John Davidson, in *The Army Quarterly*, January, 1921.

[2] Editorial, *The Army Quarterly*, April, 1921.

exchanged. A combined staff would also provide a suitable source to which the President, the Secretary of War and the Secretary of the Navy could have recourse for advice. With such a staff, would it have been likely that, as happened at one period in the recent war, the War Department and the Navy Department would have different policies?

So radical a departure from our usual practice will doubtless take a long time to bring about. The public must be educated to support it, and perhaps too the army and the navy. There may be also prejudices and interests to be overcome. That it will come inevitably some day, cannot be doubted. Meanwhile, since the first step, the exchange of army officers to the Naval War College and of naval officers to the Army General Staff College, has already been taken, the next step, the exchange of observers and staff liaison officers ought to be demanded and ordered. Then, in case of war, we would have at least a substitute of some value and a source of mutual understanding and of coördination; and, when the combined staff becomes a reality, we shall have officers ready and partially qualified to serve upon it, and to devise a common doctrine.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE SUPER NAVY. THE U. S. NAVY

By GRASER SCHORNSTHEIMER

Egotism is in the makeup of all of us. From admiral to newspaperman there is that "I want you to know how important I am," idea firmly implanted into each individual personality.

I can make no excuse for it—they would not remedy the fault. I have it, my readers have it and the world has it. It is there and it exists. To merely acknowledge it and pass on is not sufficient. It must be taken into consideration in all our plans and it must not be allowed to run away with our just discrimination or sway our opinions.

Undeniably, Americans are braggers, and sometimes with little to brag about. Naval officers, civilians and all others are included in this. During the past year or so, this sort of thing has been working steadily to the detriment of the navy. It must be checked at once.

The American citizen has been harangued with America's super-superiorness to such an extent that he believes his country to be infallible, unbeatable and entirely indispensable to every other nation. Now this is all well and good from a patriotic standpoint, but its practical side reflects only supreme neglect of the more important functions of our national government.

Once before we have had a situation identical to the present one. Especially among navy men have I found that the lesson of this situation was well known, but somehow or other it has been neglected. Also, there exists a very decided tendency to brag and "ego" away its rightful effect. After the Civil War our navy, which was supposed to be the most powerful in the world, rusted to pieces on the stocks. Most of my readers know the details of this far better than I do. What I want to drive at is the underlying reason for it, that it may not happen again.

Most of the navy will answer me that it was the "lack of sufficient funds from Congress." Yes, that was the direct cause, but that is old stuff—just plain "passing the buck," for the real cause is much deeper.

As a newspaperman I have had to make rather a complete study of the psychology of Mr. Ordinary American Citizen, who happens to be in the great majority. Of late I have been writing almost exclusively for American naval expansion and I have run up against this trouble. I have located it and am taking this opportunity to bring it to light.

Advertising and press agenting the United States Navy as the most powerful and only infallible naval force in the world is responsible for the defeat of the General Board's program for new ships and for the exclusion of other essentials from our new naval appropriation bill. Our people have been led to believe that we have sufficient ships, planes and everything else—for didn't we build everything by the "millions" during the war and were we not ahead of everyone else by a terrific margin?

Hasn't it been said since the war that we are ahead of even England?

A year or so ago, a high naval officer wrote a magazine article in which he pointed out that our navy would be the most powerful in the world within a few years. This article was accepted as authority by almost every newspaper and news service in the country and it was widely copied. The only difference was that most papers rewrote it "*is* the most powerful." Hence the people accepted it and to-day they believe further naval expenditures are unnecessary and in Congress assembled, they refuse to be bled. I am dealing with the people through the columns of the newspapers every day and I am quite sure that this is their opinion, for I have tried my best to help change it, only to be thwarted by some totally unjust superlatives.

Since that article was published, England has decided to build four ships of more than 43,000 tons displacement, to carry eight 18-inch guns. These ships will undeniably maintain England's position as the first naval power. Also, the Japanese naval program is coming to light and from the details of the first eight ships of the new program it is to be seen that unless the latter six battleships of our 1916 program are completed we will be well on our way to the third naval position and if the information con-

cerning the latter eight ships of the Japanese program is at all correct, we will drop back to third place whether our big ships are completed or not.

But the American people stand convinced, by what has been more or less authoritatively published, that further naval appropriations are unnecessary. Not only this, but even the best informed imagine our 1916 program as totally complete. "It doesn't take six years to build a battleship," they say. Some may laugh at this because of its evident injustice, but only a short time ago I received a letter from one of the editors of a rather large inland paper, requesting me to get him some information as to "how well the *new* battleship *Indiana* did at the last target practice."

To-day, the people of the United States as a whole, can be interested in the navy. That is, they will take the trouble to read a navy news story if they see one, even in Kansas. The reason for this is that their sons found there was an ocean during the war, and they found it was a rather tough proposition. One must remember that 80 per cent of our voting population has never been aboard a battleship and the great majority of them never will. The navy will always be a vague dream to them. When asked to dig down into their pockets for extra taxes for the navy, which to them scarcely exists, they feel imposed upon, especially when they believe that the navy doesn't need the money.

Recently I visited one of our 1154-ton destroyers. She was at anchor in the Hudson. I came aboard as a casual visitor from an inland town, anxious to see one of these ships which performed so gloriously during the war. To my intense surprise I learned that we have the most powerful and best destroyers agoing. This rather aroused me and I asked concerning the new British flotilla leader *Shakespeare* and the destroyers of the *V* and *W* classes and about some of the Italian destroyers carrying 6-inch guns. I was observed with some surprise at this, but had I been the average civilian I represented myself to be, I would have most certainly left that boat confident that that particular vessel and all American destroyers in general, were the most wonderful boats of their type in the world. Now, as Mr. Ordinary Citizen from Oshkosh, I would say that the General Board's recommendation for flotilla leaders was all bosh and that the navy was powerful enough; being more powerful than any other navy. And I would base this opinion

on what I had personally seen and heard and I would stick to that opinion.

This same sort of talk, this super-superiorness stuff, is unquestionably handed out to the newspapermen. Now the newspaperman, as a general rule, cannot properly discount any statements handed to him. He isn't an engineer and he isn't properly informed on naval affairs. He is supposed to know everything and in fact he knows nothing well. To-day the newspapermen are getting to be parrots, or rather stenographers for the transmission of what somebody else says.

Only recently the new battleship *Maryland* went to sea for her builder's trials. Almost simultaneously, news statements from the various news services stated and proclaimed the advent of the world's most powerful warship. The British *Hood* was forgotten, or never heard of, the Japanese *Negato* and *Mutsu*, larger, faster, and firing a heavier broadside, were nothing alongside of the "most powerful ship in the world." They were not even considered, for if they had been the *Maryland* would not have been the "most powerful ship in the world." Yet all the people all over the country have been given the impression that we have the world's most powerful warship and that three ships just like her will be completed shortly. Now, in their opinion, why should we build more warships?

Another instance of just this is in the case of our battle cruisers, "the most powerful ships of their types in the world, when complete." Why is it that when these statements of recent date were given to the newspapermen that the Japanese *Akagi* class of four ships was not considered? Everyone in this country believes that we will have the most powerful battle cruiser squadron in the world when they are complete. Four of the tremendous *Akagis* and the four *Kongos* will make no difference, of course.

Another thing. Can any one explain to me why nearly every naval officer in talking for publication, considered all the ships of our 1916 program as complete after the lesson of the aftermath of the Civil War?

Because of this lesson I must refuse to consider any ship not 50 per cent complete as even "to be completed" during an indefinite period, unless I have positive knowledge of a Congressional appropriation which will actually complete them.

The newspaperman wants a big story. The bigger his stories, the more prestige he has in his office. Give him a finger and he'll usually take a whole hand. The naval officer he approaches for his story seems to think, judging from the printed stories, that it is unpatriotic not to make his subject the "greatest in the world." Personally, I have found this true. If I had swallowed some of the things told me about the navy, I would have most certainly printed some big stories, but after using a pinch of salt and a little just discrimination, I have used only what I believed to be right and fair.

A continuance of the use of superlatives on the part of those who give the interviews and talk to the people aboard ship or at a dinner, has but one result—that of an entirely inferior American Navy.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

RIGID AIRSHIPS

By LIEUT. COMMANDER GARLAND FULTON (C. C.), U. S. Navy

EDITOR'S NOTE.—This article was submitted before the unfortunate *R-38* disaster. It contains, however, much information of current interest in regard to rigid airships.

The prospective acquirement of *ZR-2* (ex-British *R-38*) and the construction in this country of *ZR-1* mark the addition to the United States Navy of a new type of craft and make of current interest an outline of the characteristics of a modern rigid airship. A large amount of speculation has already been published as to the future possibilities of large airships both for commercial and military purposes. What, therefore, will probably be of most interest is a general description of rigid airships as they exist at their present stage of development, with an introduction consisting of a brief outline of some of the landmarks in their evolution up to the present.

A rigid airship is distinguished from other types by the rigid framework enclosing the lifting elements so that the gas pressure is not relied upon to retain the form of the ship, either entirely, as in the non-rigid type, or in part, as in the semi-rigid type.

GERMAN DEVELOPMENT

Although construction of small airships of the non-rigid and semi-rigid types had been underway for a number of years in several countries, and a crude rigid type, which employed a petrol engine for the first time in an airship, was attempted by an Austrian named Schwartz in 1893-97, the first serious efforts to produce a rigid airship date from 1898 when Count Ferdinand Von Zeppelin, a cavalry general of Franco-Prussian War fame, and formerly Prussian Military Attaché in this country during the Civil War, employed two engineers, Kober and Kubler, to assist

him in the design, and formed a company for the building of this new type of airship he had long contemplated. He became so closely identified with rigid airship development that examples of the type became popularly, and later officially, known as "Zeppelins." His early work was contemporary with that of Santos-Dumont with small airships of non-rigid and semi-rigid types, who, while probably far from being the scientific student of airship construction that Zeppelin was, served to arouse popular enthusiasm by his dare-devil public performances in Paris and may be regarded as the inspiration of the increased activity in all airship work evident at this period.

Construction of the first rigid airship proved a formidable task, rivaling as the ship did in size and displacement a large ocean liner. This *Zeppelin I* while crude bore a close resemblance in principles of construction to those immediately succeeding her. The hull structure was an aluminum and wire framework built on the "keel girder system" followed in all the early Zeppelins up to *L-3* (*LZ-24*) as distinguished from the "hull girder system" of modern ships. The backbone of the structure was a single longitudinal girder or keel of built-up section and strong enough to act as the main strength member, placed just below the hull proper. The sixteen transverse frames, each forming a 16-sided polygon, were erected vertically from equidistant points along the keel; apexes of these transverse frames were connected by longitudinal members running from end to end of the ship; a network of brace wires connected longitudinals and frames completing a light framework enclosing the gas bags and transmitting their "lift" to the keel girder. Two cars were provided, one forward, one aft. Also, four propellers driven by shafting from two engines placed inside the cars. The gas bags were made of cotton cloth proofed with a rubber solution and the outside cover was of linen stretched taut by the application of a shrinking solution comparable to our modern "cellulose acetate dope." The external appearance presented was that of a long pencil with rounded ends—a not very efficient aerodynamic shape. The ship was of 400,000 cu. ft. capacity; 416 ft. long; 38 ft. in diameter and weighed ten tons, including a useful load of about one ton. Two 16-horsepower Daimler benzine motors were used, and on her first trials held in the summer of 1900 a speed of 17 miles per hour was obtained. Stability and steerability were fairly satisfactory and the ship

became the prototype of all modern rigids. This ship was followed in 1905-08 by *Zeppelin II, III* and *IV* embodying progressive changes and improvements.

The interest of the whole German people in the large ships was at once very great and the first recognition of the military possibilities of the rigid airship appears to have been in 1908 when, after a demonstration flight of the modified *Zeppelin III,* witnessed by the Kaiser and on which the crown prince was carried as a passenger, Count Zeppelin was decorated as "the greatest German of the century." Soon afterwards this ship was taken over by the government and rechristened *Zeppelin I*—the first rigid airship to be taken into military service.

Four similar ships were soon ordered for the German Navy and this announcement at once prompted other inventors and designers to activity. Of these, Dr. Johann Schutte, of Danzig, a naval architect of considerable attainments stands out prominently. As will be seen he infused many principles of the shipbuilder into airship construction to the lasting benefit of the latter. Aided by his financial backer, Lanz, the Luftfahrzeugbau Schutte-Lanz (Schutte-Lanz Co.) was established at Mannheim and became an active rival of the Luftschiffbau Zeppelin (Zeppelin Works) at Friedrichshafen. This rivalry between these, the only two rigid airship building plants in Germany, still continues although during the war the government apparently forced a pooling of design information, patent rights and ideas to their mutual advantage.

The Schutte-Lanz Company claims, and with considerable merit, they have contributed more than has the Zeppelin Works towards improvements in rigid airship design and that even their earliest ships included characteristics in advance of their time, as shown by their later adoption by all designers of rigid airships. The first *S-L* airship was designed in 1908-9 and completed in 1911. The ship displaced 724,000 cu. ft.; was 430 ft. long; 60.3 ft. in diameter; carried a useful load of 10,000 lbs., and made a speed of 42 miles per hour with two 250-horsepower Mercedes engines. The type was notable on account of its superior streamlined form compared with that of contemporary Zeppelins, in that the greatest diameter was placed in the first third of the length, giving the ship a fatter appearance. The slenderness ratio, or diameter-length ratio, was

1 to 7.1 as compared with 1 to 9 for existing Zeppelins. It is of interest to note that the slenderness ratio of subsequent German rigids has shown a gradually decreasing tendency until in their latest type to be flown it has reach 1 to 6.5. Other interesting features of the *SL-1* were its simple single control surfaces in contrast with the cumbersome box-type multiple control surfaces of the Zeppelins; elastic car suspension which is now almost universally adopted; propellers driven by simple spur gears; and the peculiar hull structure, a trellis framework composed of diagonal wood members running spirally around the ship from stem to stern with occasional transverse rings so that the external appearance of the hull before being covered was not unlike that of a battleship cage-mast turned to a horizontal position.

The second ship, *SL-2*, completed in early 1914 was larger than *SL-1;* 883,000 cu. ft. capacity; 473 ft. long; 59.7 diameter; useful load 17,600 lbs.; speed 55 miles with four 180 Maybach engines. She contained further features of improvement; an interior walkway for convenient communication and stowage of bulky materials, at the same time reducing the over-all height of the ship and improving its aerodynamic efficiency; also, the car arrangement was improved by placing a pair of wing cars farther away from the axis of the ship and closer to the hull, thus giving increased ground clearance and better propeller distribution. The automatic gas valves were placed in a low position with ventilation shafts leading up vertically from them. A similar system is used to-day. In preservation of the analogy to the sea-going ship, engine telegraphs and telephones were provided. Wood girders of triangular cross section were used, but the diagonal system of framework was abandoned as too complicated in favor of longitudinal members with main and intermediate transverse rings. The Schutte-Lanz Company continued to use wood for structural members almost to the end of the war when they were about to construct a ship of duralumin tubing. The glue in early ships appears to have been poor, and when Schutte-Lanz ships were used by the Navy joints opened up and caused trouble until a new method of fabrication was found which overcame the difficulty.

In 1909-10 the Deutsche Luftfahrt Actien Gesellschaft (German Air Travel Company) was formed, with the Zeppelin Works

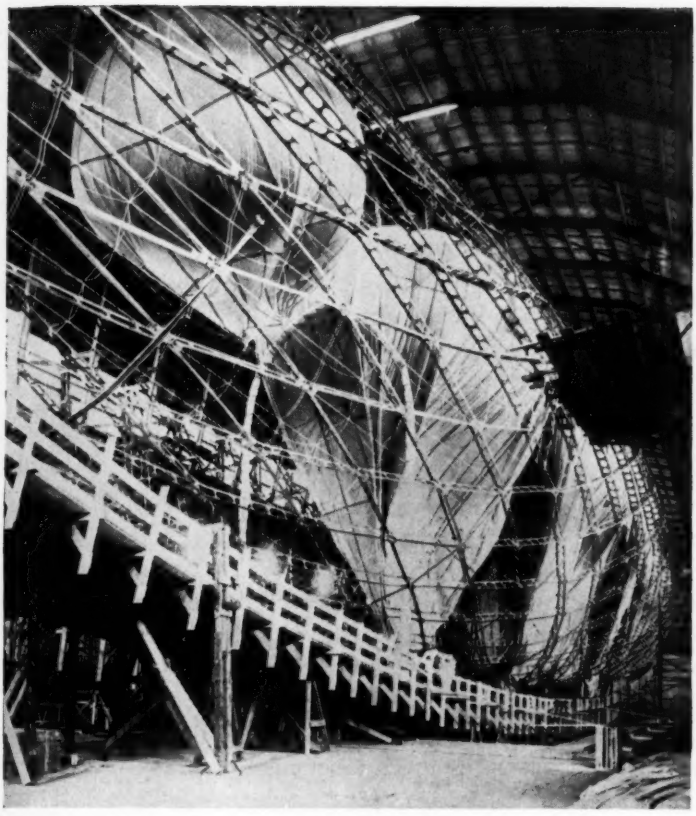


FIG. 1.—Skeleton of *SL-1*. Gasbags Partially Inflated. Note Spiral Framework.

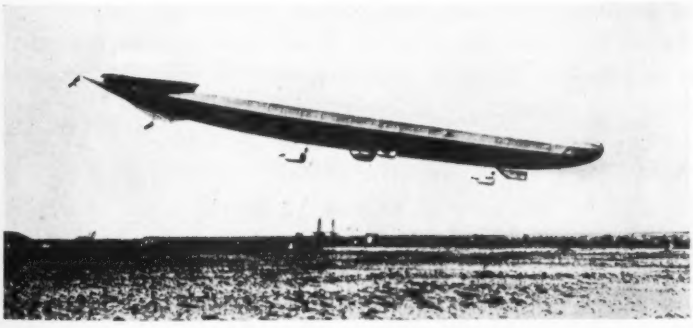


FIG. 2.—*SL-2*. Early Type of Schutte-Lanz Ship—Streamlined Shape and Monoplane Control Surfaces.

retaining an interest, to operate among a group of German cities, employing some older Zeppelins and the *Zeppelin V* which was to be constructed of a remarkably light but stiff alloy "electrometal" (probably duralumin). This company, in spite of discouraging damage to one or two ships in early operations was able to operate at a profit in addition to a subsidy from the government for the use of the ships in training army and navy airship crews. During the period of 1910-1914, over 37,000 passengers were carried in comfort and luxury on 1600 trips, a total distance of 325,000 miles without any fatal accident to passengers or crews. One ship, the *Victoria Luise,* is known to have made 200 trips in 250 consecutive days—a noteworthy record.

In spite of some disasters and financial difficulties, the Zeppelin Works continued to build ship after ship. By 1914 a total of 27 rigids had been completed in Germany of which 14 had been lost by various mishaps or dismantled as obsolete, leaving 13 in existence at the outbreak of the war—12 Zeppelins and one Schutte-Lanz ship. Besides remarkable improvements in general and detailed construction, the capacity of rigids had grown steadily from 400,000 to about 900,000 cu. ft.; their power from 32 to 840 horsepower; their speed from 17 to 55 miles per hour; their percentage of useful to gross lift from 20 to nearly 40.

German progress in rigid airships during the war is mainly a story of ever-increasing efficiency gained through constructional improvements to reduce weight as regards both hull and machinery. All that could humanly be expected was accomplished. Under the impetus of military necessity more technical improvements were effected during the four years of war than would otherwise have been accomplished in a decade. Even under stress of war conditions time was found to make systematic changes in a group of similar ships changing one variable only at a time. The results must have been very instructive.

At the outbreak of war only one ship, the *L-3* (*LZ-24*), was controlled by the navy as against 12 by the army, a fact that appears strange on first thought, but was probably because existing ships were not competent to carry out the exacting long patrols demanded by the navy. However, their usefulness to the navy had been realized and negotiations were already underway

with the Zeppelin Works and Schutte-Lanz Company for the construction of a number of superior ships. One-half of the next 64 ships built went to the army and the other half to the navy. Of the succeeding 43, 35 went to the navy, thus showing the trend of opinion as to their naval usefulness. Naval officers were found to be the most successful pilots as they brought with them, owing to their experience at sea, a quantity of knowledge useful in the navigation and handling of large airships. When they could be spared, officers with submarine experience were the most promising material.

Naturally the first war-period ships were built to existing designs, but improved designs were shortly forthcoming and soon it was the Admiralty that was most actively engaged on rigid airship construction. Along with the development of the airships themselves appeared a host of other problems that had to be solved. It was realized very early that the airship, being essentially a long-distance scout, would be useless on active duty without a reliable means of communication. A suitable radio was, therefore, installed and elaborate precautions taken to insure its continuous functioning.

Service opinion as to desirable performance characteristics obeyed its infallible rule and changed rapidly with the changing phases of the war. At one time stress was laid on endurance; at another great lifting capacity; at another high speed; at another high ceiling; but always reliability. It is interesting to note that all the German airships used Maybach engines built under control of the Zeppelin works. This was as much a matter of expediency as a tribute to the engines, although they are perhaps the best types of airship engines existing to-day. The size of the ships very soon increased to about 1,250,000 cu. ft. in the *LZ-40* (*L-10*) and *SL-6* classes. It is around this capacity, which implies a useful load of 15 tons that the military value of the type begins to be approached, but does not become fully realized until capacities of nearly 2,000,000 cu. ft. are reached.

The first ships representing the combined thought of the Zeppelin Works, the Schutte-Lanz Company and the German Admiralty were those of the *L-30* class, the first of which was completed in 1916. On account of their large increase in volume to 1,940,000 cu. ft. they are sometimes referred to as "super-Zeppelins." In these ships the hull was of much improved streamlined form; single

control surfaces and balanced rudders were provided; and the gangway was placed inside the hull; all of these features being existing Schutte-Lanz practice. The five-car and six-engine six-propeller arrangement first used was a combination of Schutte and Zeppelin practice, but this was shortly abandoned and all propellers carried directly on the cars as in Schutte ships. A new type of structural arrangement was introduced in that the girders forming the sides of the main polygonal transverse frames were stiffened by the provision of a king post extending inwards. Intermediate longitudinals, lighter than the main longitudinals, were supported at main transverses on short posts projecting outwards in line of the extended axis of the king posts. *L-33* (*LZ-76*), the third of this class, and embodying minor improvements, was completed in

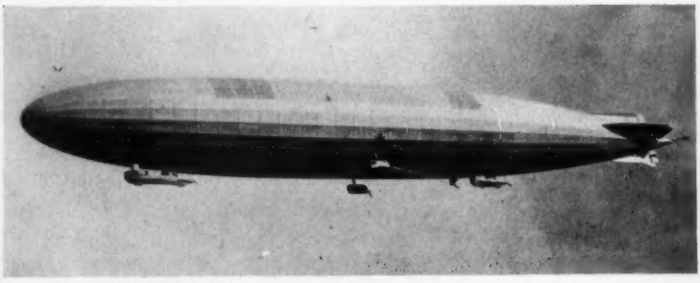


FIG 3.—*L-30* (*LZ-62*). First of the So-Called "Super-Zeppelins" Representing the Combined Ideas of the Zeppelin Works, the Schutte-Lanz Company and the German Admiralty.

September, 1916. Almost immediately she took part in a raid on London, was damaged by gun fire and forced to land almost intact in Essex. The British authorities were able to make a thorough scrutiny of the wreck and the results of this and other studies of Zeppelins are plainly evident in the designs then under preparation for the British *R-33* class.

As is natural to expect, losses were many during this period of intensive accumulation of knowledge of this new service. It is interesting to note in this connection that no German airship was lost during the war through structural failure and this fact is the more remarkable on account of the indeterminate nature of the structure and inexact state of the theory and method of calculations. The average pre-war life of a German rigid seems to have been about 16 months; the average life in war service about 14 months.

In considering these figures due weight must be given to the rapid evolution process underway and to the number of purely military casualties. A number of ships were disposed of as "obsolete" before they would otherwise have been deleted. The figures are not good evidence as to the probable life of a modern rigid airship. What this is, remains to be determined.

A great handicap in the use of rigids was lack of sheds and although construction of a limited number was started after some delay caused by doubt in the German mind as to how long the war would last, the shortage always existed and considerably throttled

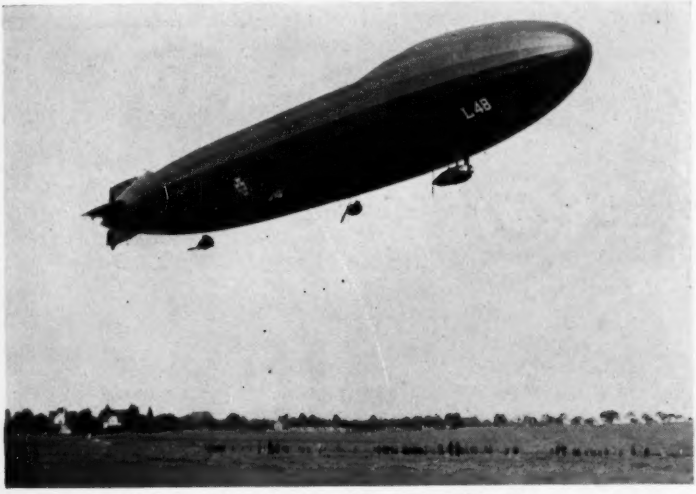


FIG. 4.—1916 Type Zeppelin (*L-48*). One of this Class was Forced to Land in France and Became the Source of much Valuable Information for the Allies. Lower Half of Ship is Dark Colored for Night Operations.

the possible building and use of rigids. Before the war the navy had built one revolving shed housing two ships at Nordholtz, and German authorities still adhere to the revolving type of shed as the only solution to the perplexing problems of housing and handling rigid airships. It frequently happened with fixed sheds, in spite of docking rails, and other assisting mechanical devices, that cross winds prevented ships from leaving their sheds on the very occasions they were most needed. Perhaps 20 large sheds were constructed at various points, but the work of the more modern rigids was principally concentrated at Witmundshaven,

Alhorn and Nordholtz; also at Tondern until the sheds there, as well as several rigids, were destroyed by an airplane bombing raid.

In spite of shed limitations improvements in types and increases in size to secure higher speed and increased lift continued steadily. Sometimes a ship would be enlarged by the insertion of a section of parallel middle body and if the resulting ship was too large for her shed a bay window-like extension was provided to accommodate her. A very high degree of efficiency in the construction of rigid airships was attained. It is reliably reported that in 1918 the Zeppelin Works was able to turn out completed ships at the rate of one every six weeks. The reason for the much smaller number of Schutte-Lanz ships is easily found in this company's small plant and, until near the close of the war, its modest sized shed.

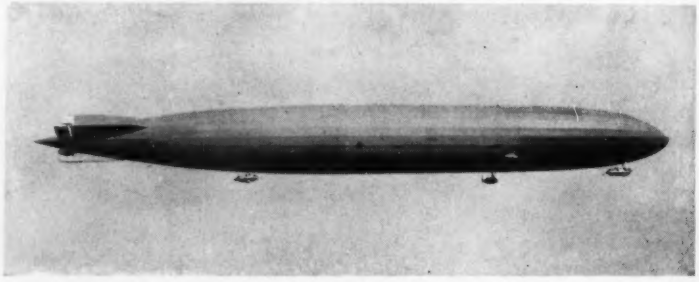


FIG. 5.—*L-57* (*LZ-102*). Large Zeppelin of Long Radius Type That Made Voyage to East Africa. 2,400,000 Cubic Feet; Speed 63 Miles Per Hour; 51 Useful Tons.

Then, too, the company was somewhat embarrassed by the difficulties connected with the transition from wood to duralumin as the chief building material.

The details of the German step-by-step war development can best be got by a glance at the chart referred to later. It will be sufficient to mention here that from 1916 changes in design were in detail only and not fundamental. The size of the ships increased to a maximum of about 2,400,000 cu. ft. in *L-71* (*LZ-113*) which was singled out from the other two ships of her class to be lengthened and, hence, enlarged.

Conditions imposed by the Armistice caused an abrupt cessation of airship activity. Several airships were broken up before the Allies had an opportunity to intervene to save them, while building was immediately discontinued on seven more. The Armistice

Commission, which visited Germany in December, 1918, found a few rigids intact in their sheds, and others partially completed—notably *L-72* (*LZ-114*), one of the largest German rigids built, which has subsequently been completed and included in a group of seven distributed among the Allies—two to England; two to France; two to Italy; and one to Japan. The United States did not share in this distribution.

In spite of the unsettled state of internal affairs after 1918, the Germans, remembering their successful antebellum experience,

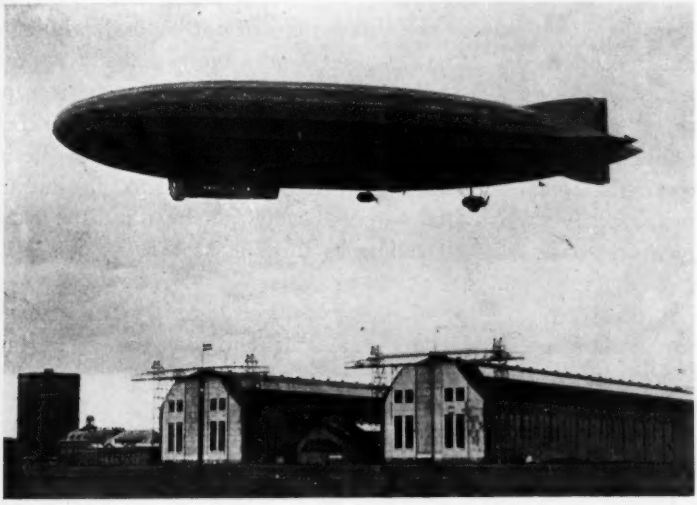


FIG. 6.—Passenger Airship *Bodensee* in Flight, 1919.

organized a regular passenger service between Berlin and Friedrichshafen employing two small, high-powered, fast ships—*Bodensee* and *Nordstern*—of 732,000 cu. ft. capacity. These ships were thrown together in about five months, a remarkably short time for a new design, and it is suspected that parts already fabricated for late-type Zeppelins were used in their construction. At any rate they incorporate some of the technical progress of the war, and are advanced samples of the art, except as to size. They are not, however, revolutionary as has been sometimes reported. This passenger service continued successfully throughout the summer of 1919 charging a fee of 400 marks for a 375-mile journey, including free luggage up to 30 lbs. It was finally stopped

by the Inter-Allied Control Commission and the ships recently turned over to France and Italy. This commission is still discussing the matter of replacement with Nordstern type ships the airship tonnage which should have been turned over to the Allies, but was destroyed after the fashion of Scapa Flow; also, the question of what disposition shall be made of the large rigid sheds in Germany.

It seems clear that the Armistice interrupted German plans to build much larger ships. The Schutte-Lanz Company was already building the largest their building sheds could accommodate, but larger sheds were underway and designs of correspondingly larger ships in preparation. The Zeppelin Works evolved about that time the design of the *LZ-125* class to be of about 3,500,000 cu. ft. capacity and nearly 800 feet long. This is the maximum size that could be built in the Friedrichshafen sheds. Except for size the design was similar to earlier ships. In spite of assertions to the contrary, work was never started on one of these large ships and the design appears to have been altered so as to be classed as a commercial ship and, as such, has been rather extensively advertised.

As illustrating the possibilities of large airships there may be pointed out a few of their accomplishments during the war. Many different kinds of reconnaissance and offensive expeditions fell to their lot varying with the progress of the war and taking them over the whole face of Europe—Russia, Asia Minor, the Black Sea, Galicia, Africa, France, Great Britain and Scandanavia. In the first years of the war a group of airships simultaneously patrolling the entrance of The Bight was sufficient to insure ample warning of enemy raids and to cause great annoyance to British submarines operating in the vicinity. The figure indicates the path some of the patrols took. A by-product of this work was the location and buoying of mine fields for the information of German mine sweepers and submarines. Airships were of outstanding importance to the operations of the High Seas Fleet and were able to keep it fully informed, a service which Admiral Scheer mentions with gratitude. In spite of unfavorable weather conditions in the North Sea area the co-operation and reconnaissance of airships were of vital inportance to the German fleet. At Jutland ten (10) rigids were out, but were handicapped by the low visibility conditions which prevailed. They were able, however, to furnish some valuable information in the last phases of the battle. The

sortie of the German fleet in August, 1916, was accompanied by eight Zeppelins which, proceeding in advance, were able to guide the squadron and develop its attack.

It is reported* that *L-40* (*LZ-88*) came to a landing on the water and held up a steamer to examine its papers. Also that in 1917 near Horns Reef Lightship, *L-23* (*LZ-66*) overhauled a Norwe-

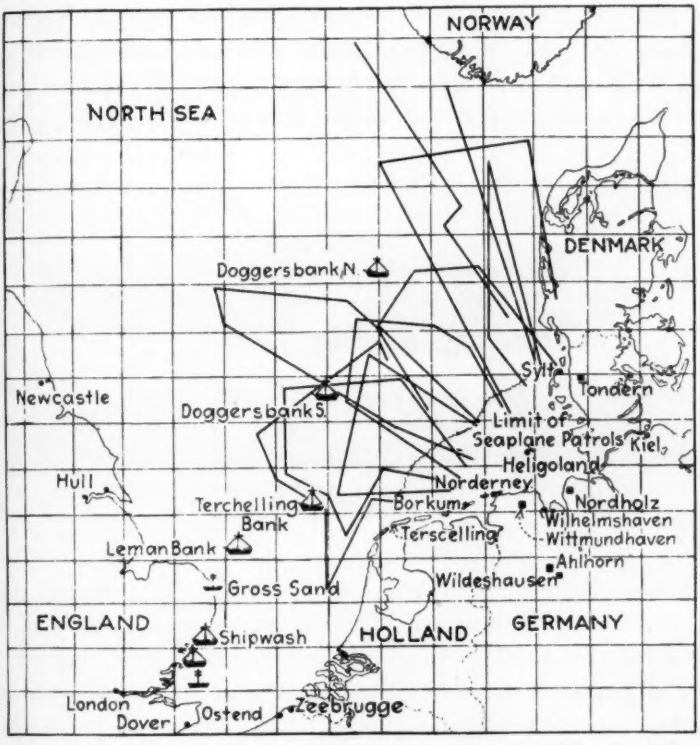


FIG. 7.—Routine Airship (and Seaplane) Patrols Maintained by Germany in the War.

gian bark, landed on the water close by, and put a prize officer on board who brought the bark safely to a German port. The risk to material involved in such exploits makes them hardly believable. *L-16* (*LZ-50*) carried supplies to outlying German island provinces in the far North Sea which were in danger of famine. A rigid airship transported munition-making machinery from Aus-

* Neuman, The German Air Force in the Great War.

tria over Bulgaria (while still neutral) to Constantinople. But the most remarkable voyage of any airship during the war was that of the enlarged *L-59* (*LZ-104*) on the initiative of the navy in the autumn of 1917 to carry 20 tons of medical supplies and munitions to troops in German East Africa and to bring back General Von Lettow. Starting from Jamboli, Bulgaria, the ship crossed the Mediterranean, flew diagonally across Egypt to Lake Victoria Nyanza where having accomplished more than half the journey she was recalled by radio from Nauen sent in the erroneous belief that the East African force had been captured. The ship returned safely to Jamboli after requiring 96 hours for the non-stop journey

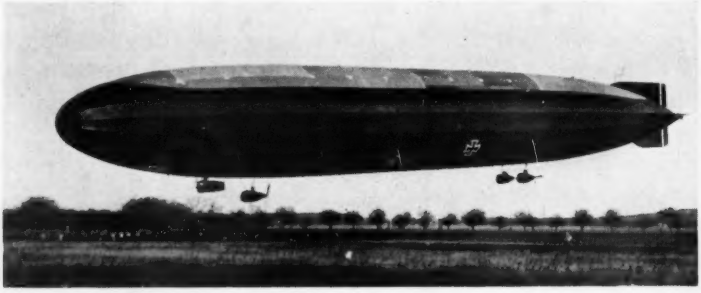


FIG. 8.—Late (1917) Type Schutte-Lanz Ship. 1,978,000 cubic feet Capacity.

of about 4500 miles without benefit of meteorological service, and over an unexplored region. Captain Buckholt reported that he could have remained in the air comfortably for another 48 hours.

The airship raids on England and France are familiar to all. At first these attacks were delivered from 3000 ft., later increased to 15,000 to 18,000 ft. as the British system of defense was developed through anti-aircraft guns, powerful searchlights and airplanes. At these high altitudes unfavorable meteorological conditions appear to have caused more discomfort than did airplane or barrage attack. However, the Germans themselves realized that such raids, while having some moral effect, were not a proper function for large airships and this may account for their decreasing frequency during the later stages of the war.

TABLE I*

SUMMARY OF THE ULTIMATE DISPOSAL OF RIGID AIRSHIPS BUILT BY GERMANY

Disposition	Zeppelin	Schütte-Lanz	Totals
1. Dismantled—Obsolete	11	5	16
2. Dismantled—Army Airship Operations Abandoned	11	2	13
3. Shot Down in War	15[1]	1	16
4. Hit by Gun Fire and Wrecked	17[2]	0	17
5. Wrecked, Storm, Forced Landing, etc.	12	3	15
6. Wrecked, Bad Landings, etc	11	5	16
7. Destroyed in Shed by Fire	14[3]	3	17
8. Destroyed While Handling on Ground	4	0	4
9. Destroyed by Fire in Flight	4[4]	2	6
10. Turned Over to Allies	7[5]	0	7
11. Wrecked Deliberately Since Armistice	7[6]	0	7
12. Building Discontinued	6	1	7
13. Now in Commission	2[7]	0	2
Totals	121	22	143

[1] One shot down by aviators.
[2] Two burned after wreck.
[3] Seven destroyed due to aviator's bombs.
[4] Two fell burning, cause unknown.
[5] Two each for England, France, Italy; one for Japan.
[6] All wrecked in sheds deliberately to evade Armistice conditions.
[7] *Bodensee* and *Nordstern*, *LZ-No. 120, 121*. Allied commission claims these as replacement for (6). Recently turned over to France and Italy.

SUMMARY DIVIDING GERMAN RIGID AIRSHIPS INTO GROUPS ACCORDING TO OWNERS

	Zeppelin	Schütte-Lanz	Totals
Civilian	12	1	13
Army	40	12	52
Navy	63	8	71
Building Discontinued	6[1]	1[2]	7
Totals	121	22	143

[1] Naval airships. [2] Army airships.

No fair appraisal of their worth can be made unless illustrations of airships' weaknesses are given. An inspection of Table I showing ultimate disposition of German rigid airships is illuminating in this connection. Sixteen were shot down in war, one by an aviator; gunfire was a contributory cause to seventeen more losses; fires, six of which occurred in flight, account for 23 more; while bad handling and landings, or forced landings, are responsible for 31 wrecks.

*From compilation of data from German sources published in *Automotive Industries*, May, 1921.

The greatest drawback to the military use of airships is their vulnerability, but of those destroyed or damaged by gunfire the majority of the losses were on bombing raids prior to 1918, and in practically all cases the damage was done while flying at low altitudes—9000 feet and under. The Germans apparently realized the risk these raids entailed and, at first, accepted it. The later types with ceilings of 15,000 feet and more gave a better account of themselves. Only three cases can be found of fatal enemy damage to a rigid while operating with the fleet. By 1918 the British had developed a counter measure to Zeppelins in the form of fighting airplanes flown from turrets of battleships and, while this no doubt served to keep the Zeppelins at a more respectful distance, the loss chargeable to an aviator was accomplished by an airplane flown from a shore base.

The losses from fires in the air are few whereas, eliminating seven destroyed by bombs during air raids on Tondern and other bases, 10 were destroyed by shed fires. This number seems inexcusably high, but may have been partly due to hastily recruited and inexperienced crews. The same reason no doubt contributed to some of the losses through handling on the ground, although weather conditions would likely be the larger factor.

It may be concluded that forced landings are serious affairs and generally result in wrecks. The antidote is obviously to secure greater reliability and so reduce the chances of a forced landing. A notable example of a forced landing is that of *L-49* (*LZ-96*) in October, 1917, at Bourbonne Les Bains, France, after having been harassed by airplane gunfire in an attack on England. The immediate causes of the landing were exhaustion of personnel from operating at extreme altitudes and engine failure due to freezing. Efforts of the crew to fire the ship on landing were frustrated and the recovery of the ship's structure almost intact provided the source of much valuable design information for the Allies, and ourselves, for French engineers, with great thoroughness, carefully measured and recorded dimensions of each part, no matter how small. *L-49* was of the same form and dimensions as *L-33* previously shot down in England, but detailed refinements resulting in a considerably lighter weight, and a correspondingly greater useful load, had been made.

BRITISH DEVELOPMENT

The average German will insist that all British rigid airships are belated copies of German types and may go even farther to say that the transatlantic voyage of *R-34* is, therefore, in reality a triumph of German skill and ingenuity. But this is not quite the case, for while several laps behind Germany until 1918, British talent has contributed a number of advancements to the art.

The first rigid to be built by Great Britain was the *Mayfly*, constructed by Vickers for the Admiralty and completed in 1911 but never delivered. The design represented the combined ideas of naval constructors and Vickers' engineers. In some respects the ship was ahead of her time. She was of fairly good form and had a better arrangement of machinery and propellers than did contemporary German ships. The "keel girder system" was used with duralumin for structural members. The ship was of 700,000 cu. ft. capacity and was powered by two 200-horsepower Wolsey engines. On her first trials she was moored by the nose to a floating mooring mast near a dock for three days and successfully weathered a small gale during that time. This is the first instance on record of the use of a mooring mast for large airships. After subsequent trials, due to a misunderstanding of orders, she was almost totally wrecked by being carried against the shed door while being housed. It is unfortunate the promising start made with this airship was not followed up vigorously so that good rigid airships would have been available at the outbreak of war, but instead interest and progress lagged.

At the end of 1913 all airships then in possession of the army were transferred to the navy, and from then until 1918, the responsibility for the development of airships, including rigids, rested with the Admiralty wherein an Airship Section was at once organized. Coincident with this revival of interest in airships, a contract was placed with Vickers for the *R-9*, of the same general design and size as existing German rigids. She was of 889,000 cu. ft. capacity; 526 ft. long; speed 45 miles per hour. Construction was started promptly, but proceeded slowly. In March, 1915, the Admiralty directed that work be suspended as it was then considered the war would end in a few months. However, the effective work of German rigids and the continuance of the war caused this decision to be reversed. After numerous design changes and

delays, *R-9* carried out successful flights in the spring of 1917, and subsequently gave very satisfactory service on patrol and as a training ship. During her life of two years and three months, she flew a total of over 2500 hours.

From 1915 rigid development was pushed with energy until after the Armistice. Besides Vickers, orders were placed with Armstrong-Whitworth, Beardmore and subsequently, with Short Bros., at Bedford. In some cases, sheds and building plants were up for these concerns practically at Admiralty expense.

The next class of rigids was the *R-23* class, four ships, constructed largely to Vickers designs and embodying a number of

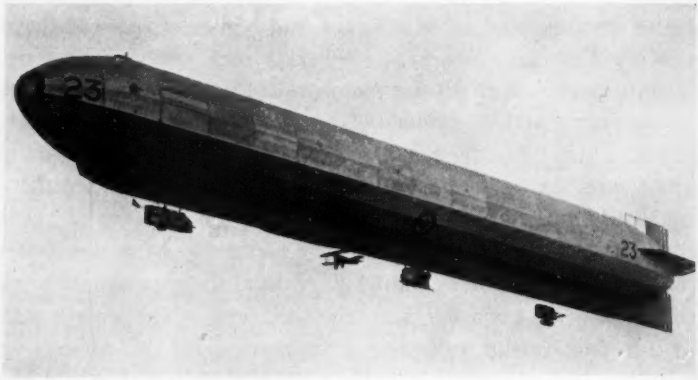


FIG. 9.—British *R-23* Carrying Fighting Airplane Which Was Released and Made a Successful Flight.

improvements, although still closely resembling their German antecedents. They had single rudders and in common with most British rigids were very staunchly built and heavy which involved a reduced useful load. They were 997,000 cu. ft. capacity; 535 ft. long; carried a useful load of 6 tons; and made a speed of 55 miles per hour with 1000 horsepower. All were not completed until 1918, something over three years behind equivalent German ships. However, they proved to be useful ships. *R-24* was subsequently used for mooring experiments and successfully remained moored out for 42 days in all sorts of weather. The *R-23X* class comprises *R-27* and *R-29*, ships slightly smaller but very similar to *R-23*, and notable for the omission entirely of a keel as such, thus becoming a pure hull girder type. *R-31* and *R-32* were wooden ships after Schutte-Lanz ideas. Casein glue was

used, but difficulties were encountered due to seams opening from dampness just as Schutte had found. *R-31* was shortly condemned and *R-32,* while enjoying a longer life, has recently met a similar fate. These ships were of 1,550,000 cu. ft. capacity, and were very fast, making 65 miles with five 250-horsepower Rolls-Royce engines.

On inspecting *L-33* in late 1916, it was realized that all the earlier British ships were useless except for training and the Admiralty promptly ordered several modern ones of the *R-33* class, based on the German *L-33,* but revised during construction, principally as to car and propeller arrangement, on later information got from an inspection of *L-49.* This class compares closely with *L-49,* but includes a number of minor improvements based on British experience. Their somewhat more rugged construction permitted only 45 per cent useful load as against 50 per cent for *L-49.* Two ships, *R-36* and *R-37* were to be similar to the *R-33* class, but larger by a ten meter section amidships.

Just after the Armistice, and during the construction of the *R-33* class, most of the Admiralty personnel engaged on rigid airship work were loaned and transferred to the Air Ministry. When the Air Ministry was first established rigid airship work remained under the Admiralty and the desirability of the change has not been proved by subsequent developments. There are many who hold to the idea that large airships are essentially naval and, therefore, should be designed and maintained as part of the fleet.

Armistice Day found Great Britain with six active rigids and four more under construction. Operating berths were available for 14 ships. With the reduction of military services to a peace basis, there came a general aircraft depression, particularly deep in regard to rigid airships; the number of ships in commission was reduced and the activities of those remaining were much curtailed. Completion of *R-33* and *R-34* was permitted and although too late for war service, these ships have given a good account of themselves. *R-33* has made several notable demonstration flights over eastern Europe and the Baltic and the transatlantic flight of *R-34,* 3600 miles in 108 hours, is still fresh in the minds of every one. This latter is the outstanding post-war achievement by any airship.

After *R-33* and *R-34,* British designers began to consider the production of ships of larger volume. They now had at their disposal considerable first-hand experience besides a mass of

data from inspection of German rigids and through intelligence sources. This is summed up in the *R-38* class, comprising three ships, two of which were canceled. She is not a copy of, but is related to the last German rigid to be completed (*L-72*). One distinct improvement is the replacement of the German type king-posted girders of main transverses by a full-trussed frame consisting of four girders forming an elongated diamond with a brace across the short diagonal. Although of increased volume, a larger diameter permits a more economical structure while giving a good streamlined form, which it is expected can be driven at a speed of nearly 70 miles per hour. Arrangements were made by the Air Ministry to take over the works of Short Bros. at Cardington (Bedford) as an experimental building establishment and to continue there under direction of Air Ministry officials experimental construction of this new design which was worked out in late 1918. On account of their small shed, Vickers could not build the later and larger type ships, so to avoid complications they were allowed to build a small ship, *R-80,* to their own designs. The ship is complete, but seems to fill no military purpose and is being used as a training ship.

Table II gives a summary of the disposition of British rigids as nearly as can be ascertained. Except for number one, called the *Mayfly,* the letter "R," evidently for "rigid," followed by a numeral has been used as a designating symbol. The apparent gaps in the series are filled by airships not of rigid type or by rigids that were assigned numbers but never completed. Why "*R-80*" was selected is not clear.

Ever since the Air Ministry took over the control of rigid airships there has been great discussion as to what policy should be followed. The net result is there appears to be no policy. Undoubtedly with a lean treasury, rigid airships are a big problem, but so long as they continue to serve as a bone of contention between Air Ministry and Admiralty little advance in the art may be expected. Attempt has been made to turn over to commercial concerns for operation some of the idle ships, particularly *R-36,* whose car arrangement was specially changed to suit commercial work. So far no concern has been found that will agree to the stipulated terms and the matter remains in the discussion stage. Meanwhile, *R-36* does such errands as regulating traffic to the Ascot Races and does it very efficiently.

In early 1921 *R-34* met with an unfortunate accident while on practice flight and was later broken up by a storm while attempting to place her in her shed at Howden. This was the last psychological straw to the already depressed British mind, and for a time it looked as though large airships would be abandoned entirely. However, the recently completed and very successful trials, with an improved type of mooring mast, have opened up new possibilities

TABLE II

SUMMARY OF ULTIMATE DISPOSAL OF RIGID AIRSHIPS BUILT BY GREAT BRITAIN

Type	Remarks
(*R-1*?) *Mayfly*	Wrecked, 1911.
R-9	Deleted, 1918.
R-23	Placed out of service.
R-24	Used for mooring experiments. Out of service.
R-25	Used for static tests. Out of service.
R-26	Placed out of service.
R-27	Burned in hangar.
R-29	Broken up in static tests.
R-31	Wood ship. Unsatisfactory. Placed out of service.
R-32	Wood ship. Broken up, 1920.
R-33	In service.
R-34	Wrecked in handling, 1921.
R-36	Adapted for commercial purposes. In service.
R-37	Under construction.
R-38	Under construction. Sold to U. S. A.
R-80	In service. (Training ship.)

SUMMARY.—14 completed. Three in service; two under construction; total 16.

NOTE.—*L-64* and *L-71* (German ships), turned over to Great Britain under terms of the Peace Treaty, are not in service.

and served to materially change this opinion. Signs of increasing optimism and activity are becoming apparent. If a satisfactory method of mooring out large airships can be found a long step forward will have been made and, apparently, this has been done.

As to their use during the war, 1914 found Great Britain with no rigid airships of any military value and in fact it was only after the good work of the German Zeppelins became increasingly evident that she was aroused from her lethargy and made frantic efforts towards a construction program. This lack of foresight has been

severely criticized although it can hardly be called lack of foresight, since Admiral Jellicoe and others appear to have realized the value of rigid airships to a fleet, but were unable to overcome the inertia of some of the councils in which they sat. One argument against building any was that to rival Germany would require too many ships. Another argument was their vulnerability as evidenced by the rather heavy losses of the Germans in raiding northern towns, forgetting that such bombing raids were not a legitimate function for fleet operating airships. When the country realized the extent of German developments the Admiralty had to bear the brunt of much criticism for their reactionary policy.

The slow development of the building program, if program it may be called, prohibited anything like large scale operations. This is particularly to be regretted as one can conceive with Britain's undisputed control of the North Sea, and thus able to protect her aerial scouts, rigid airships could have been of inestimable service to the Grand Fleet. As it was there is not much to be said of the accomplishments of British rigids during the war. Their work chiefly comprised (1) operations with the fleet or detached units; (2) anti-submarine patrol and searching for mines; (3) escort of shipping, though this was mostly done by small non-rigids. Rigids, if available, would have been used for long-distance convoys.

FRANCE AND ITALY

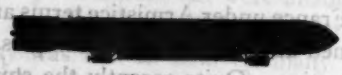
The history of rigid airship development in France and Italy is almost negligible. Most excellent work was done in France on small and medium-sized non-rigids and semi-rigids by Lebaudy, The Astra Co., Clement Bayard and the Zodiac Company. However, nothing in the way of rigids was attempted until the Zodiac Company, in 1913, completed the *Spiess*, a rather crude 575,000 cu. ft. rigid which was similar to the Zeppelin type, but was not a success. Further activity did not appear until the value of the Zeppelins to the Germans became apparent and their characteristics driven home by an inspection of *L-49*. It has already been related how this carcass was minutely inspected and recorded. The results formed the basis for a French design of rigid and at least one was about to be ordered from Schneider when the Armistice caused the scheme to be abandoned. Since the Armistice France has shown great nervousness as to the ultimate disposition of large German

rigids, their sheds, and building plants, and seems to prefer that future building be confined to the smaller sizes. Two late German rigids were turned over to France under Armistice terms and apparently these are being retained and scrutinized as samples, possibly with a view to their duplication. Quite recently the small *Nordstern*, a passenger ship, has also been confiscated and delivered to France. It is reported that it will be used for passenger service to Morocco.

Italy has built no rigids, but semi-rigids have been developed extensively. Semi-rigids have been built up to 1,200,000 cu. ft. capacity and the *Roma* of this type was recently purchased by our War Department. Two late German rigids, and at least one large shed, have been delivered under the terms of the Peace Treaty. Their disposition is uncertain, but it is rumored that at least one ship has been deleted through handling. A rigid design has been prepared and construction is being considered, but there are no funds.

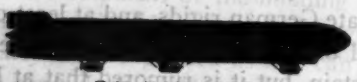
There is included a chart (Chart I) illustrating some of the principal steps in the development of German and British rigids. The classification is more or less arbitrary and omits minor changes in types. It would be too cumbersome to illustrate all of the variations that are of interest. There is also included Chart II listing the general characteristics of German, British, and United States rigids subsequent to 1913—that is the war and post-war types. Again the classification is arbitrary and omits many variations. It may be considered as an elaboration of the latter part of Chart I. While these charts are believed to be fairly accurate the data from which they have been prepared emphasize the wide discrepancies likely to be met in comparing data on the same airship from several sources. There should be, but there is not, a recognized standard set of conditions to enable accurate comparisons to be made. For example, the endurance of an airship may vary one hundred per cent depending upon whether the bomb load, or cargo, is omitted and an equivalent weight of fuel carried (extra fuel tanks being generally installed for this purpose). Similarly, the cruising radius of an airship, like that of a surface ship, varies much with the speed and broadly speaking increases rapidly as the speed is decreased. With airships the full value of favoring and

BRITISH

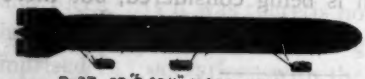


R-1 1911
1 SHIP BUILT 700,000 CU.FT
3.2 USEFUL TONS / 19.2 GROSS TONS = 17.0 o/o

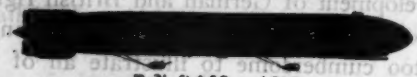
R-9 1916-17
1 SHIP BUILT 883,000 CU.FT
3.2 USEFUL TONS / 25.6 GROSS TONS = 12.5 o/o



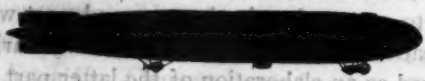
R-23 CLASS - 1917-18
4 SHIPS BUILT 997,000 CU.FT
5.7 USEFUL TONS / 28.7 GROSS TONS = 19.9 o/o



R-27 OR "R-23X" CLASS - 1918
2 SHIPS BUILT 990,000 CU.FT
8.4 USEFUL TONS / 28.6 GROSS TONS = 29.4 o/o



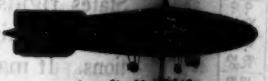
R-31 CLASS — 1918
2 SHIPS BUILT 1,550,000 CU.FT.
14.3 USEFUL TONS / 44.3 GROSS TONS = 32.3 o/o



R-33 AND 36 CLASSES — 1919-21
4 SHIPS BUILT 2,000,000 TO 2,150,000 CU.F
27.5 USEFUL TONS / 58.0 GROSS TONS = 48.43 o/o

R-80 CLASS — 1921
1 SHIP BUILT 1,250,000 C
15.3 USEFUL TONS / 36.1 GROSS TONS = 42.4 o/o

R-38 — 1921
1 SHIP BUILT 2,724,000 CU.FT.
46.0 USEFUL TONS / 78.6 GROSS TONS = 58.5 o/o

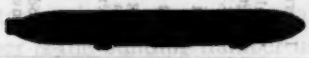


SL-20 1917-18
3 SHIPS BUILT 1,976,000 CU.FT
USEFUL TONS / GROSS TONS = 58.0

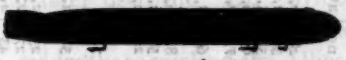
Chart I.—Development of British Rigi

ZEPPELINS

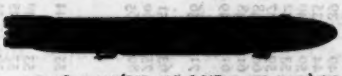
LZ-1 (EARLY TYPE)-1900
REPRESENTS 6 SHIPS — 1 USEFUL TON = 10 %
400,000 CU.FT — 10 GROSS TONS



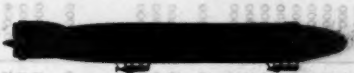
LZ-11 (VIKTORIA LUISE TYPE)-1911-13
REPRESENTS 7 SHIPS — 6.1 USEFUL TONS = 30.6 %
658 000 CU.FT — 19.9 GROSS TONS



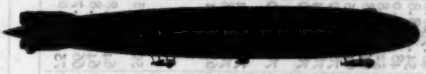
LZ-18 CLASS (L 2)-1913
REPRESENTS 4 SHIPS — 10.8 USEFUL TONS = 37.5 %
950,000 CU.FT — 28.8 GROSS TONS



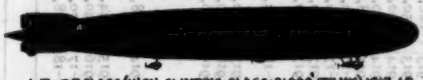
LZ-25 CLASS (PRE WAR & EARLY WAR CLASS) 1913-14
22 SHIPS BUILT — 8.5 USEFUL TONS = 35.4 %
792,000 CU.FT — 24.0 GROSS TONS



LZ-40 CLASS — 1915-16
35 SHIPS BUILT — 16.9 USEFUL TONS = 44.0 %
1,250,000 CU.FT. (ABOUT) — 38.5 GROSS TONS

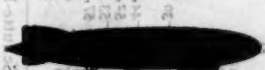


LZ-62 CLASS — 1916-17
17 SHIPS BUILT — 31.9 USEFUL TONS = 54.2 %
1,940,000 CU.FT — 58.9 GROSS TONS



LZ-95 CLASS (HIGH CLIMBING CLASS-21000 CEILING) 1917-18
19 SHIPS BUILT — 39.7 USEFUL TONS = 66.2 %
1,970,000 CU.FT. — 59.9 GROSS TONS

LZ-104 CLASS (LONG RANGE CLASS-117 HRS, 1918
5 SHIPS BUILT — 50.9 USEFUL TONS = 69.4 %
2,420,000 CU.FT. — 73.4 GROSS TONS



LZ-120 CLASS-1919-20
2 SHIPS (BODENSEE & NORDSTERN)
PASSENGER SHIPS — 11.3 USEFUL TONS = 47.0 %
796,000 CU.FT — 24.1 GROSS TONS

British Rigid Airships.

CHART II—CHARACTERISTICS OF RECENT RIGID AIRSHIPS

Designating number or class	Number built	Naval ships included	Date delivered	Volume in cubic feet	Length in feet	Diameter in feet	Lift: Gross tons	Lift: Useful tons	Lift: Useful gross per cent	Ceiling (estimated) feet	B. H. P. Total	Speed: Full power (miles per hour)	Speed: Half power (miles per hour)	Approximate endurance: Full power: Miles	Approximate endurance: Full power: Hours	Approximate endurance: Half power: Miles	Approximate endurance: Half power: Hours	Remarks
Zeppelin Works			**GERMAN**															
LZ- 15	5	.....	Early 1913	686,000	466	48.7	20.8	6.9	33.0	5,000	495	45	36					
LZ- 18	1	L-2	Sept., 1913	950,000	518	54.4	28.8	10.8	37.7	6,000	720	49	39	Data not available.				
LZ- 25	19	L-3 to 8	1914	792,000	518	48.7	24.0	8.5	35.5	6,600	630	44	35					Internal keel—monoplane rudders.
LZ- 26	3	L-9	Late 1914	880,000	530	52.4	26.8	9.8	36.7	9,000	630	50	40					
LZ- 40	22	L-10 to 19	1915	1,128,000	536	61.3	33.8	14.7	43.0	10,000	840	53	42	1,500	28	2,400	56	"Hull girder" construction,
LZ- 51	35	L-20 to 24	1915-16	1,262,000	586	61.3	38.5	16.9	44.0	10,500	960	59	47	1,600	30	2,600	60	Lengthened LZ-40 class.
LZ- 62	17	L-30 to 41; 45, 47, 50	1916-17	1,940,000	649	78.4	58.9	31.9	54.0	14,000	1440	60	48	3,100	52	5,000	104	First Zeppelin to have side cars.
LZ- 91	2	L-42, 43	1917	1,960,000	645	78.4	59.4	35.8	50.5	15,000	1200	61	48	4,100	69	6,350	128	
LZ- 95	7	L-44, 46, 48, 49, 51, 52, 54	Late 1917	1,970,000	645	78.4	59.9	38.3	61.5	20,000	1200	61	49	4,650	75	7,350	150	First use of two engines driving one propeller.
LZ-100	36 10	L-53 to 65, except 54, 57, 59	1917-18	1,975,000	645	78.4	59.9	39.4	65.6	21,000	1450	71	56	5,000	66	8,000	132	High climbing class.
LZ-104	2	L-57, 59	Late 1917	2,420,000	743	78.4	73.4	50.9	69.6	18,000	1200	63	51	6,200	84	9,900	177	Long range class.
LZ-112	3	L-70, 71, 72	1918	2,400,000	743	78.4	72.8	43.5	60.0	21,000	2030	75	60	4,500	58	7,000	120	High speed and climbing class.
LZ-120	2	Passenger	1919	796,000	425	61.3	24.1	11.3	47.0	10,000	960	80	65	1,700	22	2,800	44	Bodensee or Nordstern type.
Schutte-Lanz																		
SL- 2	1	..	1914	968,000	512	59.7	29.5	10.2	34.9	5,000	840	55	44	2,900	52	4,600	104	Wood girders; longitudinal framing streamlined shape; propellers on cars.
SL- 3	3	2	1915	1,144,000	503	64.8	34.8	13.8	39.4	5,000	840	53	40	1,300	25	2,800	50	
SL- 6	4	3	1916	1,240,000	532	64.8	37.8	18.3	48.4	6,000	960	57	45	1,600	27	2,500	54	
SL-10	10	2	1916-17	1,370,000	572	66.0	41.7	20.2	48.5	10,000	960	56	44	2,600	43	4,100	86	
SL-20	3	2	1917-18	1,978,000	650	75.2	60.0	34.7	58.0	16,000	1200	63	50	4,300	68	6,800	136	
			BRITISH															
R- 9	1	R-9	1916	889,000	520	53.	25.6	3.8	17.0	1,000	360	45	36	200	4	300	8	Multiple surface controls.
R-23	4	R-23, 24, 25, 26	1917-18	997,000	535	53.	28.7	5.7	19.9	3,200	1000	52	42	550	10	900	21	External keel; monoplane controls.
R-27	2	R-27, 29	Early 1918	990,000	539	53.	28.6	8.4	29.4	6,800	1000	54	43	1,100	14	1,800	41	No external keel.
R-31	2	R-31, 32	Late 1918	1,550,000	615	65.6	44.3	14.3	32.3	8,000	1250	65	51	1,600	25	2,500	50	Wood girders.
R-33	2	R-33, 34	Early 1919	2,000,000	643	78.7	58.0	27.5	48-49	14,400	1250	62	49	4,000	65	6,400	130	Transatlantic type.
R-36	2 4	?	1921	2,150,000	672	78.7	62.2	30.9	49.7	15,500	1400	65	52	4,250	66	6,800	132	Lengthened R-33 class.
R-80	1	?	1921	1,250,000	530	70.	36.4	15.3	42.4	12,000	1000	60	48	2,600	44	4,200	87	
R-38	1	R-38	1921	2,724,000	695	85.5	83.0	50.0	60.2	21,000	2100	69-70	55	5,000	73	8,000	146	Estimated performance.
			UNITED STATES															
ZR-1	1	ZR-1	....	1,980,000	645	78.6	56.0	28.0	50.0	15,000	1650	59	48	4,300	70	6,500	125	
ZR-2	1	ZR-2	1921	2,724,000	695	85.5	83.0	50.0	60.2	21,000	2100	69-70	55	5,000	73	8,000	146	Ex-British R-38.

Weights are in 2240 lb. tons. Miles are statute miles.
Useful tons includes (a) Fixed load—Crew, food, guns and other fixed equipment.
(b) Disposable load—Fuel, bombs, dischargeable ballast, etc.
Full power and full speed taken together.

Cruising, or half power, speed assumed about 80% of full speed.
Fuel consumption may be taken at conservative figures .55 gasoline + .05 oil = .6 lbs. per B. H. P. per hour.
Gasbags assumed full. Lift 68 lbs. per 1,000 cubic feet of gas (hydrogen).

head winds is evidenced and serves still further to make the endurance over the surface of the earth an uncertain quantity, and one that can only be approximated. Again, the total lift will vary with gas purity, fullness of bags and atmospheric conditions. Attempt has been made, however, to put all the data on one basis and so permit a fair comparison. No attempt has been made to indicate the armament or bomb loads carried, as these items varied with the nature of the expedition.

A word of explanation as to the designation of German rigids is desirable. The "LZ" number is the building number used by the Zeppelin works. Ships for the German Navy used the letter "L" (Luftschiff) followed by a numeral. The German Army used the letter "Z" (Zeppelin), but later used the "LZ" symbol, except that beginning with *LZ-72,* the numeral was 30 units ahead of the building number (*LZ-42*), evidently to mislead the Allies. Schutte-Lanz ships were built under the letters "SL" followed by a numeral. The army ships retained this designation, but the navy changed to "L" followed by a numeral indicating its sequence in the combined (Zeppelin and Schutte-Lanz) naval fleet.

(TO BE CONTINUED)

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

GRAPHICAL SOLUTION OF PROBLEMS IN NAUTICAL ASTRONOMY[1]

By CHARLES E. MANIERRE

There are a number of problems which require only an approximate solution, and which if they can be quickly solved give convenient information to the navigator. Graphical solution is peculiarly suited to this form of problem. The experience of the writer is that for the N-shaped figures about to be described a unit value of 6 inches, and for the triangular figures a base length of 10 inches, is sufficient to give satisfactory results within less than a half degree.

Such figures for practical use need not be of larger scale and should be lettered as simply as possible, omitting the function name.

If one is told to lay his ruler across the N-shaped figure so that it cuts two of the lines marked "latitude" and "declination," respectively, and on the third line where the ruler intersects it he may read the hour angle of the body when on the prime vertical, he may consider so slight an effort worth doing, and so with a half-dozen other similar problems.

In Appendix D of Muir's Navigation will be found one of these N-shaped figures taken from an article by Captain de Aquino, in No. 126, p. 633, of the PROCEEDINGS of the U. S. Naval Institute. There is too much mathematics connected with this figure to make it attractive to the average navigator. The article itself was in part historical and it developed the fact that while the N-shaped figure could be used to solve right angled spherical triangles, using the middle part and two adjacent parts, there was also a figure consisting of two lines forming an acute angle, which angle was bisected by a third line, which lines when properly lettered could be used for solving right angled spherical triangles, when the parts

[1] Copyright, 1921, by Charles E. Manierre.

involved were a middle part and two opposite parts. A reference to this article will show that the formula for lettering this last mentioned figure was rather difficult. For some reason Captain de Aquino gave his attention only to the N-shaped figure and to its use for purposes not to be attained without considerable study.

The object of this article is to comment on the N-shaped figure—to describe a new triangular figure found suitable by the writer for solving right angled spherical triangles when a middle part and opposite parts are involved, and to indicate by figures how these should be lettered for use.

A reader may construct his own without much effort. In constructing the N-shaped figure he will have to lay off a natural tangent spacing from 0° to 58° so that the line shall be very nearly 9½ inches long between these two values. The unit value for such a scale is 6 inches and is comprised between 0° and 45°. As a cotangent scale the spacings are the same, but the markings will be complementary, viz., 90° to 32°. In like manner mark a line with nat. cosine spacings from 0° to 90° and being in length 6 inches and be prepared also to letter the same spaces for hours and minutes from 0 hrs. to 6 hrs. For the triangular figures a 10-inch base may be spaced for sines and cosines by using a scale divided into 1/10 of an inch to be treated as 1/100 of the 10-inch unit and by referring to a table of natural sines for space values. If this be treated as the base line of a triangle, similar scales of any desired length may be made by intercepting the sides of the triangle by lines parallel to the base, which may be subdivided by lines drawn to the apex.

It is required in the N-shaped figures that the sides be parallel and that the unit length on both sides be the same, *i. e.*, 0° to 90° cosine will equal 0° to 45° tangent, in length. The diagonal is divided by lines drawn, or a ruler laid down, from each marked value on the tan or cot side to the upper end of the cosine line and the intersection is given the same value or the complementary value, as indicated in the figures herewith, or on the folder.

The diagonal is spaced symmetrically about its middle or 45° point so that the lower end may be lettered, though the values are not to be found on the side line. The non-essentials are, the distance which the parallel lines are apart or how far above the cos 0° point the tan 0° point may be.

In the triangular figures, except the rate of change figure, the inside parallel is spaced and lettered by lines from the base to the apex, the values given being the same as, or complementary to, those on the base.

The diagonal spacings are determined by lines from the left-hand end of the base through the values on the inside parallel, and here also the values marked are either the same as on the parallel or complementary, as indicated in the several figures.

The rate of change figure as used by the writer is a right angled triangle 7½ inches on the azimuth side with a base of 9½ inches, and the rate of change line parallel to the azimuth side and not quite 2 inches from it, but so located that it is 6 inches in length.

In constructing the rate of change figure the sine scale for Azimuth is first completed; then by using the apex of the opposite angle it may be transferred to the interior parallel with complementary markings for the temporary purpose of lettering the diagonal representing latitude, by lines drawn from the foot of the sine scale through the temporary cosine markings on the interior parallel. The intersected point on the diagonal being given the same cosine degree value. These markings on the parallel are then *replaced* by dividing it into 15 equal parts.

It is not essential that any of the triangles have any particular shape or that the inside parallel be at any special distance from the base. The effect of altering the relative dimensions is to expand or contract different parts of the scale. The writer found it convenient in the triangles other than rate of change to locate the inside parallel so that it has a length of 8 inches. He had much use for proportional dividers and found it convenient to duplicate his drawings by pricking through several thicknesses of paper with a needle the division markings, which were afterward inked for different purposes, the spacings being the same for all.

For study the figures may bear their tan, cot or cos values, but for use these are better omitted.

It will be noted that the unlettered side of the triangle could in all cases be omitted. It is only retained to give solidity to the figure.

Those who are at all interested in this subject will doubtless accept the figures herewith tentatively as correct and test one or more of them by problems otherwise worked out to a known solution. There may be others who will wish to be acquainted with the

method of constructing the figures, so as to produce them at will, and perhaps still others who will be interested in a further brief discussion of them.

This article will therefore deal first with the directions for use, then with the methods of reproducing the figures, and finally with a discussion of the subject.

With each figure will be found one or more formulas which can be solved by its use. The N-shaped figures are essentially the same as the one to be found in Appendix D of Muir's Navigation. The triangular figure is one suggested by the writer, as also the figure for rate of change in altitude. The N-shaped figure is for the solution of right angled spherical triangles where a middle part and two adjoining parts are involved as defined by Napier's Rules, while the triangular figure is to be used where the parts are a middle part and two opposite parts.

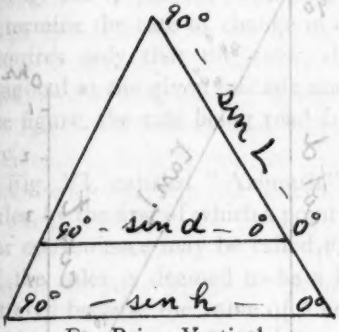
The directions for the use of Figs. I to V, inclusive, are simple. A straight edged ruler is so placed upon the figure as to intersect the lines lettered for the known quantities at their given values. The value of the unknown quantity will then be found at the intersection by the ruler of the third line. In most cases the result will be accurate within a half degree of arc. It will be found convenient to use the point of a needle or the dividers at the value located and to hold the ruler against this instrument while finding the second given value.

It will appear that in the triangular figure one side of the triangle is only drawn to give solidity to the figure and is ignored in the discussion of the subject. It will also be noticed that so far as the spacing of the two types of figures is concerned, all the figures of each type are duplicates and differ only in the lettering excepting, however, Fig. III, which is peculiar to itself although similar in general appearance to the other triangles. The parts of the other triangular figures will be described as the base, the diagonal and the inside parallel, or more briefly, the parallel.

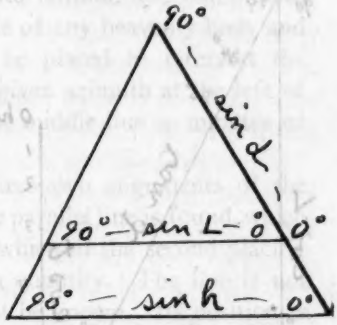
Where two solutions are to be had from one figure the values assigned to the lines and shown in brackets will be used when so indicated in connection with the formula at the side of the figure.

It would be quite possible to letter a single triangle to cover all the problems except that shown in the rate of change figure, but such a triangle would prove confusing in use.

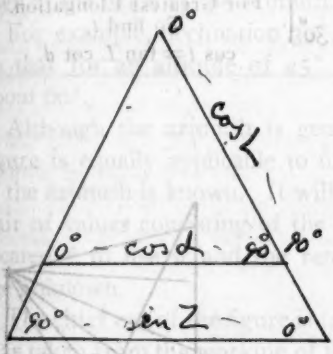
LETTERING AND EQUATIONS



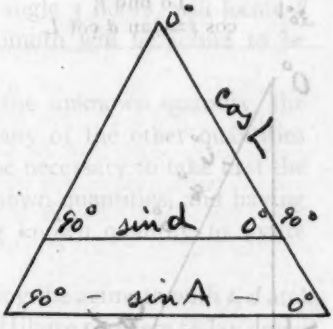
For Prime Vertical.
To find h,
$\sin d = \sin h \sin L$.



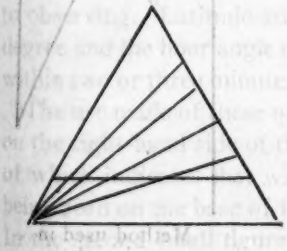
For Greatest Elongation.
To find h,
$\sin L = \sin h \sin d$.



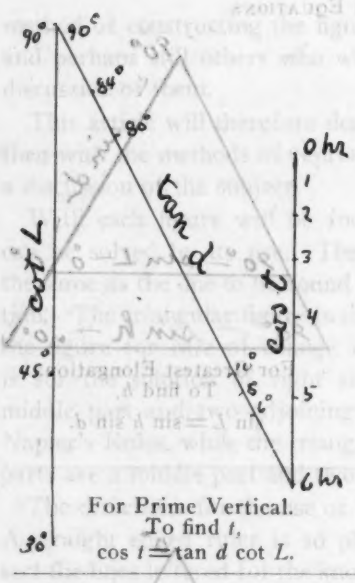
For Greatest Elongation.
To find Z,
$\cos d = \sin Z \cos L$.



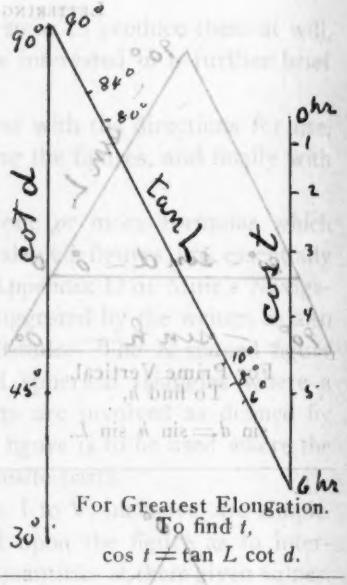
For Amplitude.
To find A,
$\sin d = \cos L \sin A$.



Method used in spacing the diagonal.

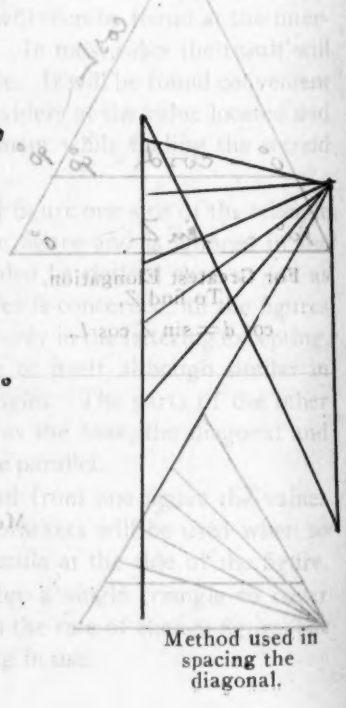


For Prime Vertical.
To find t,
$\cos t = \tan d \cot L$.



For Greatest Elongation.
To find t,
$\cos t = \tan L \cot d$.

For Greatest Elongation.
To find Z or h,
$\cos Z = \tan L \cot h$.



Method used in spacing the diagonal.

Fig. III is for use with approximate latitude and azimuth to determine the rate of change in altitude of any heavenly body and requires only that the ruler should be placed to intersect the diagonal at the given latitude and the given azimuth at the left of the figure, the rate being read from the middle line in minutes of arc.

Fig. VI, entitled "Azimuth," requires two alignments of the ruler, by the first of which a point on the parallel line is found, which for convenience may be called θ, and which in the second placing of the ruler is deemed to be a known quantity. The line is not lettered because the value of θ need not be known. Its position is held by the point of the dividers and the ruler revolved to the third known quantity. The four values in the formula are taken in pairs. Time and declination are first used in placing the ruler, and next altitude and θ, the intersection of the ruler upon the diagonal being then at the value of the azimuth.

For example, declination 30°, hour angle 3 hours, will locate θ so that for an altitude of 45° the azimuth will be found to be about 60°.

Although the azimuth is generally the unknown quantity, the figure is equally applicable to finding any of the other quantities if the azimuth is known. It will only be necessary to take first the pair of values consisting of the two known quantities, and having located θ to use it and the remaining known quantity to locate the unknown.

The chief use of the figure is for finding the azimuth with t, d and h as taken from the working of the St. Hilaire problem to lay down a position line or to check the compass readings.

Fig. VII is for use when approximate latitude and the hour angle and declination of a heavenly body are known and it is desired to obtain an approximate altitude for setting the sextant arc prior to observing. Latitude and declination may be taken to a quarter degree and the hour angle as determined for the time of observation within two or three minutes of time.

The use made of these quantities is indicated by the small figures on the right-hand side of the figure as shown on the folder the first of which indicates that with latitude and hour angle, the latitude being read on the base of the figure, sine θ is found on the parallel. In the second small figure θ is found as a cosine on the base and with latitude on the parallel, a second unknown quantity x is found

as a cosine on the diagonal. The numerical difference x and the polar distance of the body is taken as a cosine on the diagonal with cosine θ again on the base, as the third alignment of the ruler. The only exception is when the hour angle is greater than 6 hours, in which case the numerical sum of polar distance and x is taken.

It is to be noted that where the arc, whether in time or degrees, exceeds 6 hours, or 90°, the supplement will give the same sine value, hours being subtracted from 12 hours and the given number of degrees from 180°.

Below Fig. VII on the folder will be found the working of the problem both for the sun and for a star.

Fig. VII may also be used to find the right ascension and declination of an unknown body whose altitude and compass azimuth have been observed and the time noted. This use of the figures requires four placings of the ruler. These are indicated by small figures just below Fig. VII under the word "Alignments." The interpretation of these small figures is similar to that just given. The first unknown quantity to be found is θ. The second is x. The numerical difference of latitude and x is taken in all cases except where a perpendicular dropped from the body upon the meridian would fall below the elevated pole, in which case the numerical sum is taken. Using this difference the declination is found and then the hour angle. The hour angle is combined with the local sidereal time to find right ascension.

METHOD OF CONSTRUCTION

The triangular figures with the exception of the rate of change figure may be constructed with a triangle of any shape whatever, though the shape and size of the figure as shown may be deemed satisfactory. For certain purposes an increase in the space between the base and the parallel line and a change in the slope of the diagonal will serve to open out one end or the other of the spacing on the diagonal scale.

The base is divided according to the values of natural sines or cosines, the linear zero being at the foot of the diagonal and corresponding to zero degrees for a sine or 90° for a cosine scale. The parallel is similarly divided, either by an independent process or by intersecting values on the base by a line drawn from the apex of the triangle. The divisions and lettering of the diagonal are

determined by lines drawn from the left-hand lower corner of the base through the values indicated on the parallel line, which values are given to the division intersection if both the parallel and the diagonal represent sines or both represent cosines. If one is sine and the other cosine, complementary values are given on the diagonal. The degree values on the diagonal are also expressed as hour values at eight-minute intervals so as to avoid two separate space markings on the diagonal.

The rate of change figure may be constructed with a triangle of any shape. The method of construction has already been described.

The essentials of the N-shaped figure are two parallel lines intersected by a diagonal and the method of construction has been given.

It may be noted, however, that the product of tangent and cotangent of any arc is always unity when natural values are used. This fact makes the lettering possible.

It will be evident that the diagonal is not spaced according to its lettering. In fact it is symmetrically spaced about the 45° point. It is thus possible to space the end of it which joins the cosine line notwithstanding the fact that the corresponding points on the parallel line are far beyond the limits of the drawing.

DISCUSSION

The principle of the triangular figure may be illustrated by Fig. 1, in which the lines are divided $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$. It will be apparent that the method of dividing the diagonal is such that each point on the diagonal may serve as an apex of a triangle having the base *BC*, which will also have an inside parallel diminished from the original length to a value equal to that given the point on the diagonal. This reduced parallel will be again subdivided so that $\frac{3}{4}$, $\frac{1}{2}$ or $\frac{1}{4}$ of it remains if lines are drawn to the new apex from points on the base having these values. The result is that any fraction on the diagonal multiplied by any fraction on the base will give a product equal to the value of the point of intersection with the parallel as originally lettered. Instead of using numbers, arc degree values representing natural sines or cosines of the respective fractions are substituted with the result that two such degree values may be multiplied together and the degree value of their product read without the intervention of numbers. The natural sine value for example of $\frac{1}{4}$ in degrees is approximately 15°; of $\frac{1}{2}$, 30°; and $\frac{3}{4}$, 49°.

The principle of the working of the N-shaped figure may be indicated by considering any single alignment, as, for example, Lat. 42°, Alt. 46°, as shown in Fig. 2. The corresponding value of azimuth will be very nearly 30°. The decimal value of each of these quantities is shown and the product of the other two will be found very nearly equal to that at 30° on the line *AB*. Note that the numerical value .8660 on *AB* is also the fractional part of *AB* as measured from *B*.

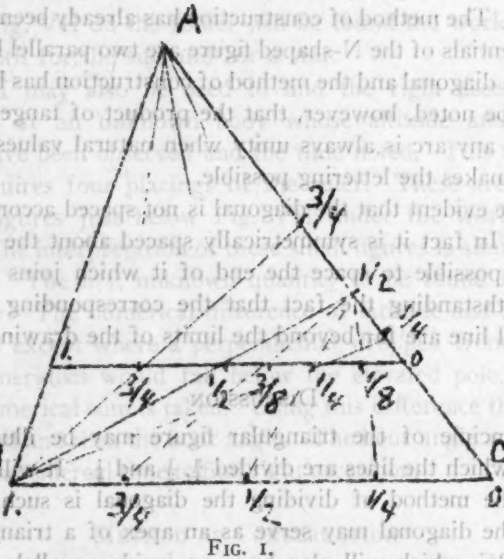


FIG. 1.

In the second figure an additional line is drawn from the unit point *A* to the point on *CD*, having the same degree value as at *E*, viz., 46°, such line passing through *E*. It will be seen that two similar triangles are thus formed, having a common apex *E* and their bases parallel. One of these is the unit base *AB* and the other a base *C*—46°, which has a linear value of 1.0355—the natural tangent of 46°. The product of this tangent value with the cotangent value of 46° indicated on the figures is unity.

Any line drawn through *E* will divide the two bases proportionately and the two bracketed distances will each bear the same ratio to the whole base of which they are a part. Inasmuch as 1.0355 on the left-hand base is reduced to unity by the multiplier

.9657, the same multiplier will reduce the 42° natural tangent value .9004 to its equivalent for a unit base which will be found to be .8660—the decimal value of 30° as found on *AB*. The same reason applies to all other lines intersecting the diagram through any value of *E* on the diagonal.

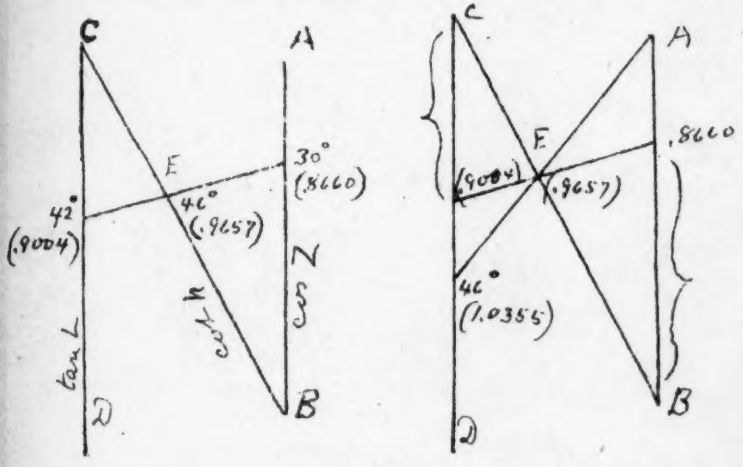
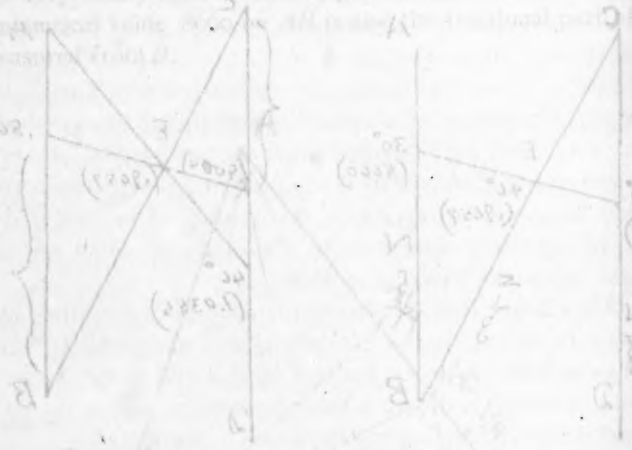
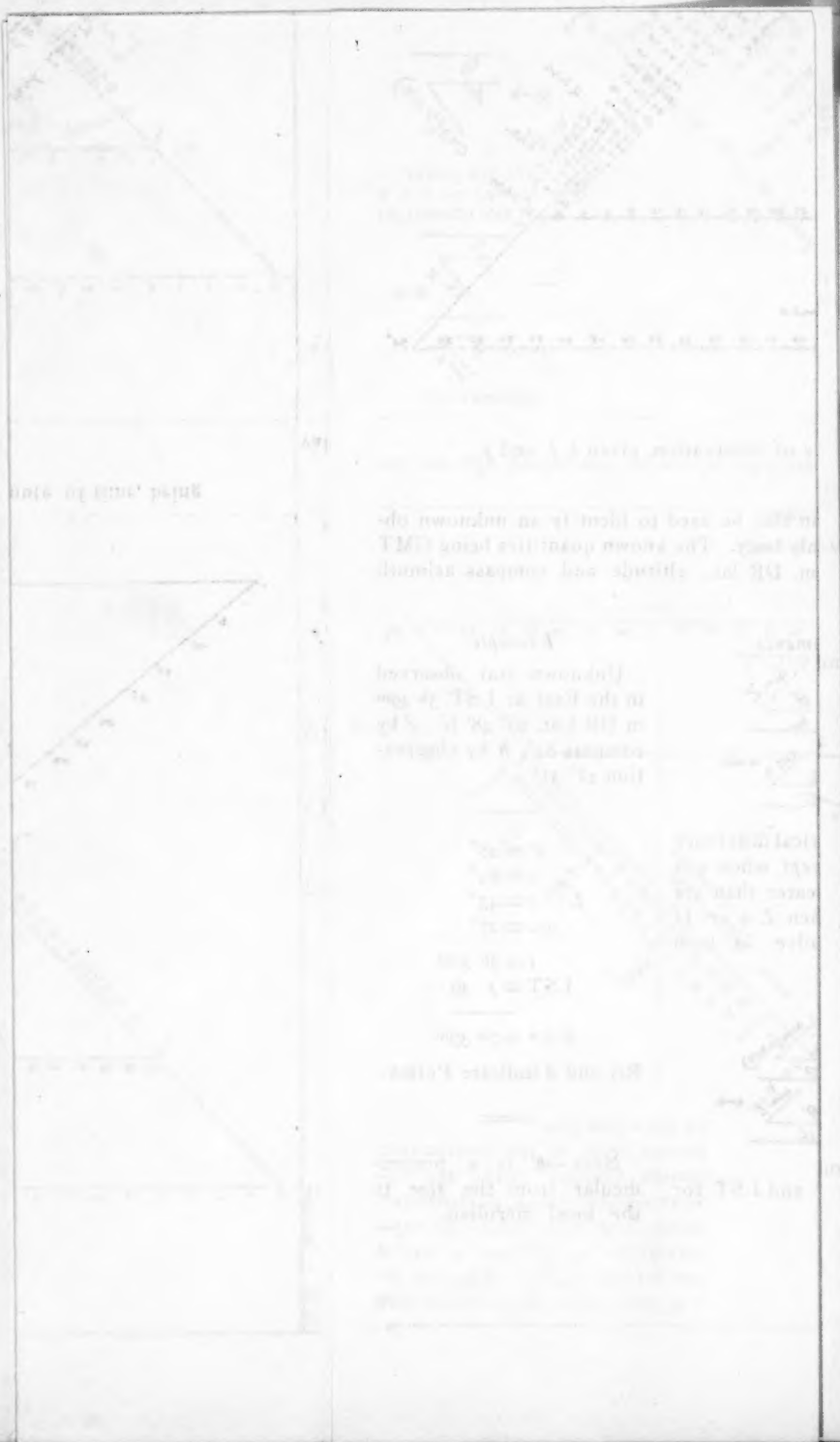


FIG 2.

In other words, the figure may be deemed to be made up of an indefinite number of pairs of similar triangles, all of which have a common apex at different points of the diagonal, with the line *CB* constituting a side of each pair and *AB* constituting the base of one triangle of each pair.

The foregoing has been hastily prepared and the writer will be glad to have called to his attention any error that may be noted or any point not clearly stated.





Graphical Solution

of

Problems

in

Nautical Astronomy

by

Charles E. Manierre

7 East 42d Street,
New York City

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by
CHARLES E. MANIERRE

The problems are to find as follows:

Hour Angle and *Altitude* on the *Prime Vertical.*

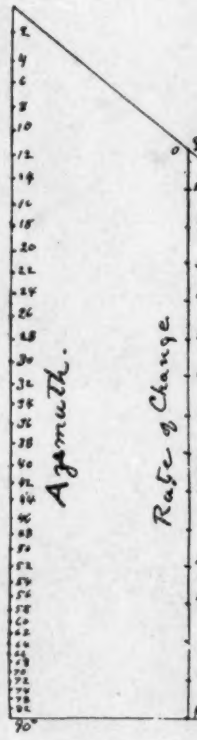
Hour Angle, Altitude and *Azimuth* at *Greatest Elongation.*

Rate of Change in Altitude per minute of time.

Azimuth when declination, hour angle and altitude are known.

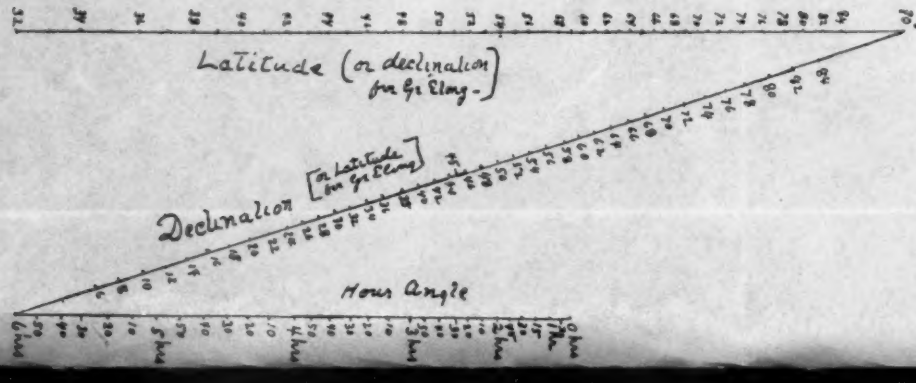
Approximate Altitude for setting sextant arc.

Right Ascension and *declination* of an *unknown body* when LST, altitude and compass azimuth are known.



Rate of Chan

DIRECTIONS.—Align the edge of a ruler on the lines representing known quantities at the given values, and read the required value at the intersection of the edges with the remaining line.



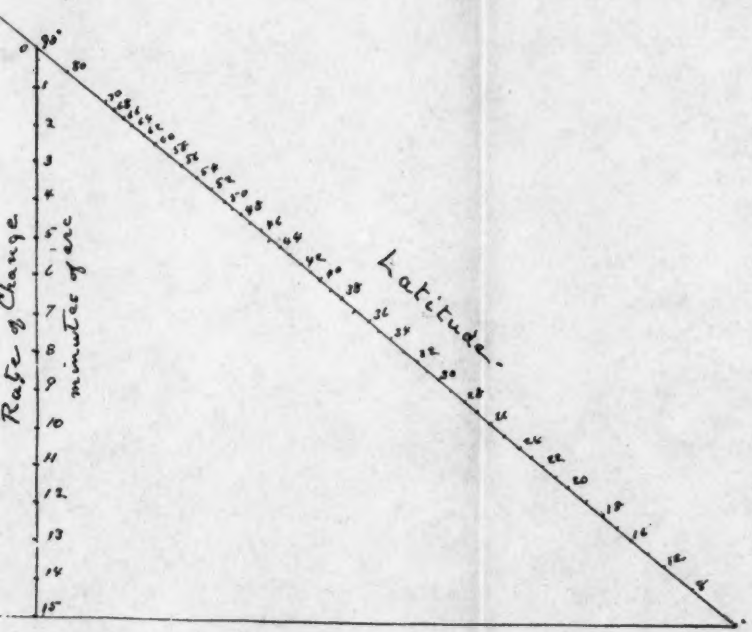


FIG. III.

Change in Altitude in minutes of arc for one minute of time, being $15 \times \sin Z \times \cos L$.

Align first the pair representing two known values. Hold the intersection of the line θ with a needle point and revolve the ruler so as to align it with the remaining known quantity. Read the unknown value at the intersection of the other line.

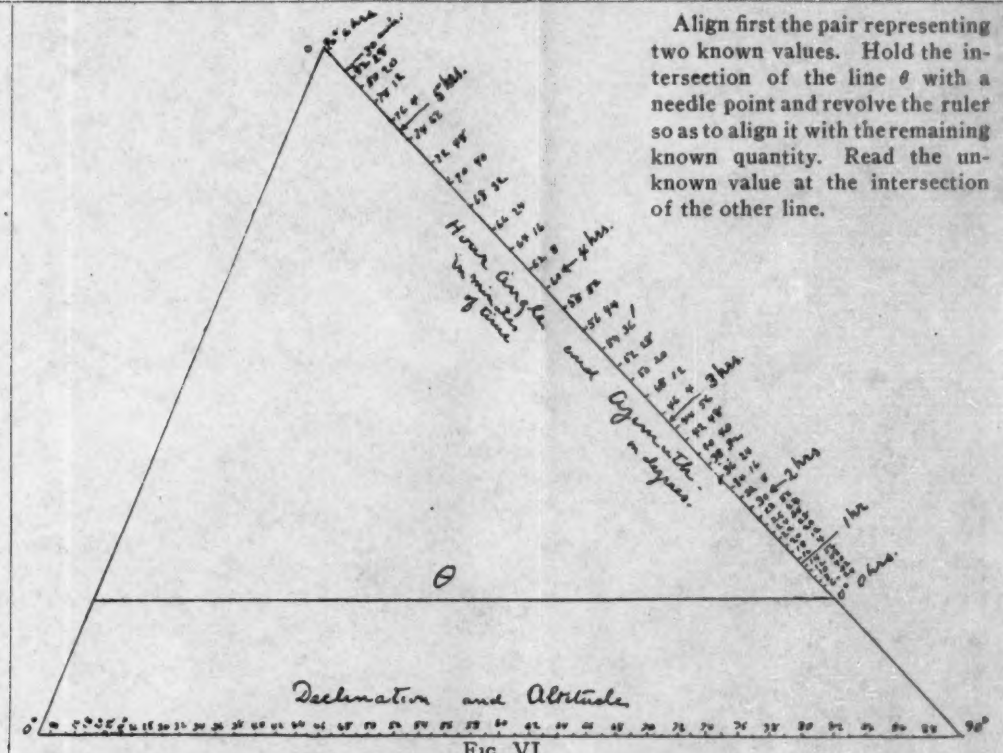


FIG. VI.

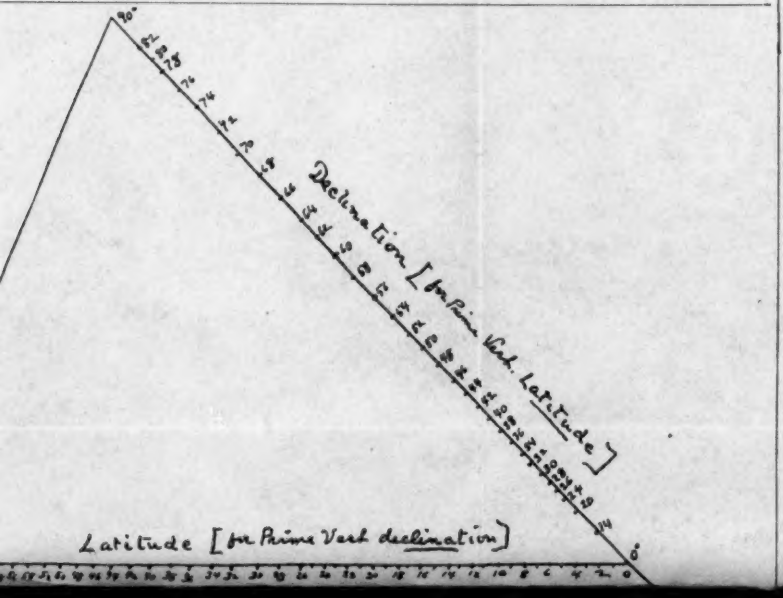
Azimuth,

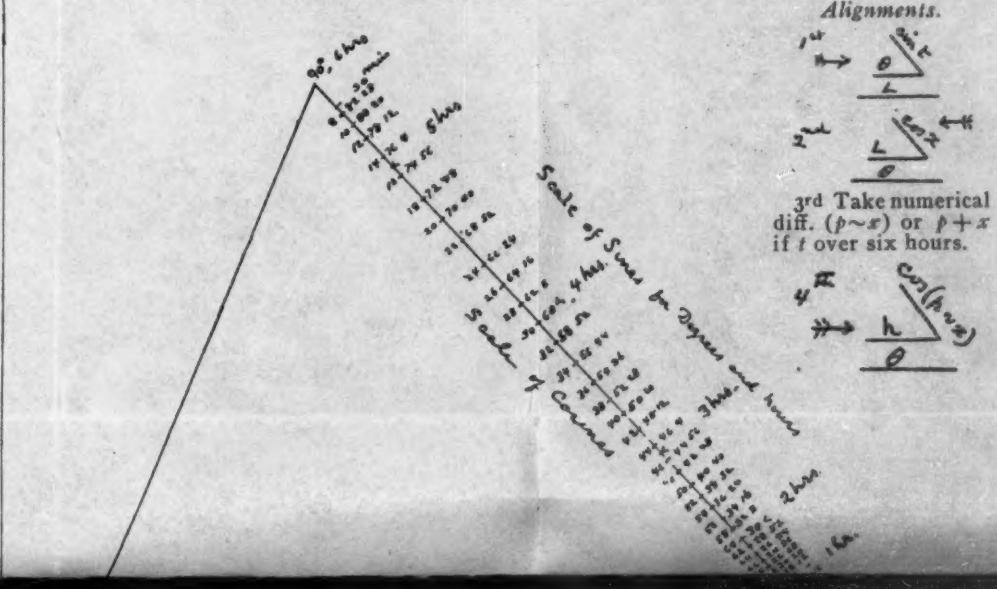
$$\sin Z = \sin t \cos d \sec h.$$

Any one of the four quantities may be the unknown.

d and t and h and Z are to be used as pairs.

Note that t and Z being found by their sines, it must be otherwise determined whether the value or its supplement is the required result.





Alignments.

3rd Take numerical diff. $(p \sim x)$ or $p + x$ if t over six hours.

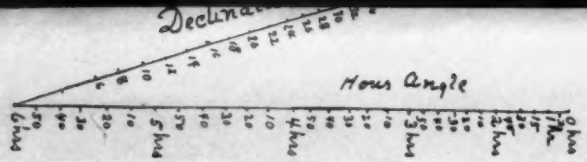


FIG. I.

Prime Vertical,

$\cos t = \cot L \tan d.$

Greatest Elongation,

$\cos t = \cot d \tan L.$

N. B. Use bracketed names for lines in the figure.

To find in either case the hour angle.

N. B. Use point of a needle or the dividers to hold first value found while aligning ruler to the other known value.

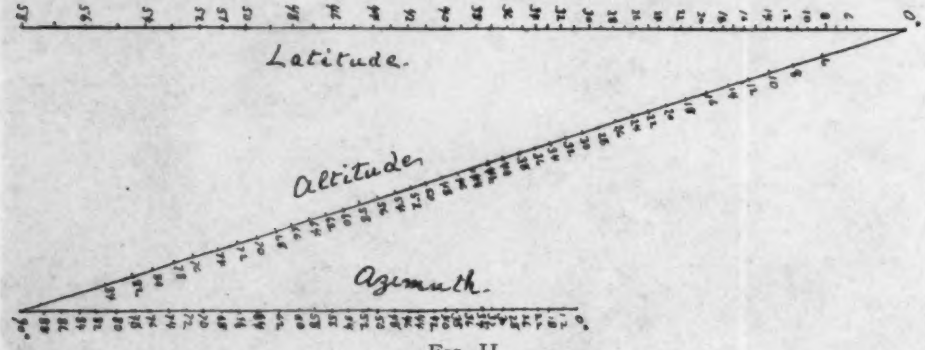


FIG. II.

Greatest Elongation,

$\cos Z = \tan L \cot h.$

To find the altitude after having found the azimuth from the triangular figure.

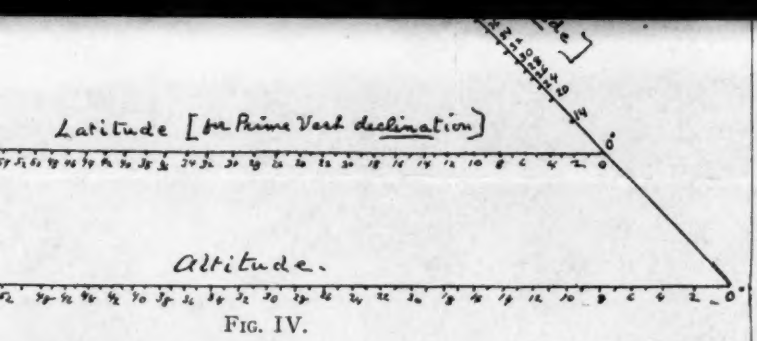


FIG. IV.

Prime Vertical,
$\sin d = \sin h \sin L$

Greatest Elongation,
$\sin L = \sin h \sin d.$
To find the Altitude.

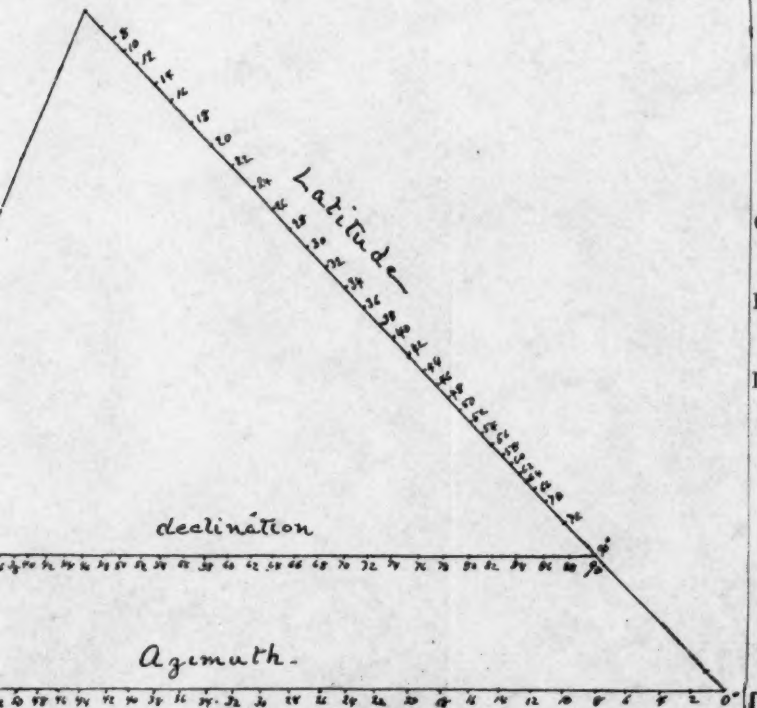


FIG. V.

Greatest Elongation,
$\cos d = \sin Z \cos L.$
To find the Azimuth.

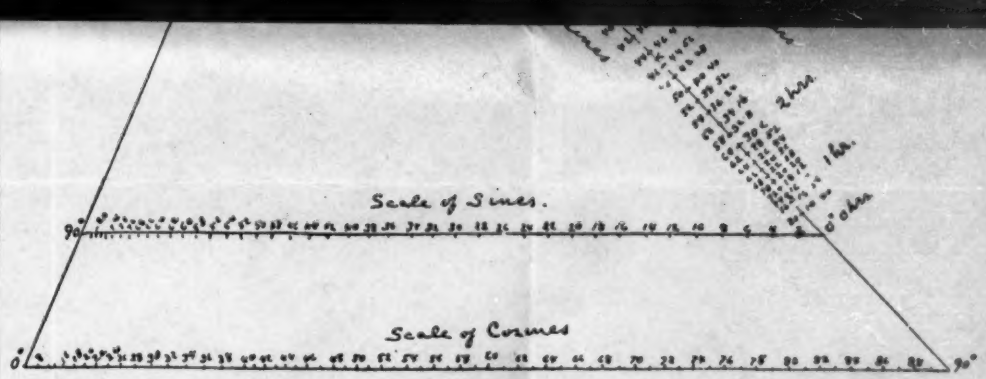


FIG. VII.

Altitude.

For setting sextant arc for an assumed time of observation, given t, L and p.

Examples of Sextant Arc Setting (Fig. VII).

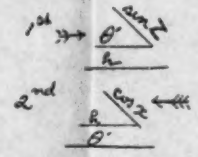
Lat. 40° 48′ N. Long. 4h 56m W

5 Feb., 1921. A. M. ⊙		6 Feb., 1921. P. M. *Pollux in East.	
GMT	2h 50m	GMT	11h 40m
λ	−4 56	RAMS	21 4
		Red	2
LMT	21 54		
Eqt	−14	GST	32 46
		λ	−4 56
LAT	21 40		
	~ 24h	LST	3 50
		RA*	7 40
t =	2h 40m		
L =	40° 48′ N	t =	3h 50m
d =	−15° 57′	L =	40° 48′ N
p =	106°	d =	+28° 13′
$p \sim x$ =	63½	p =	61° 47′
θ =	29°	θ =	40°
x =	42°⅝	x =	31°½
h =	23°	$p \sim x$ =	30°
		h =	41° 40′
[By calculation h would have been 22° 12′.		By calculation 41° 51′.]	

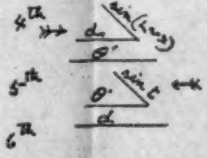
NOTE.—θ is a perpendicular from the *zenith* to the hour circle of the body.

Fig. VII can also be used to identify an unknown observed heavenly body. The known quantities being GMT of observation, DR lat., altitude and compass azimuth of the body.

Alignments.



3rd Numerical difference of $L \sim x$, *except* when t is evidently greater than six hours and then $L + x$. If in doubt solve in both ways.



Combine t and LST for RA.

Example.

Unknown star observed in the East at LST 3h 49m in DR Lat. 40° 48′ N. Z by compass 84°, h by observation 41° 51′.

$\theta' = 48°$
$x = 84°$
$L \sim x = 43°$
DEC = 27°

t = 3h 50m
LST = 3 49

RA* = 7h 39m

RA and d indicate Pollux.

NOTE.—θ' is a perpendicular from the *star* to the local meridian.

DISCUSSION

Amalgamation and Specialists vs. Corps

(See Page 1209, Whole No. 222)

Lieut. Comdr. Kenneth C. McIntosh (S. C.), U. S. Navy.—As the late Friedrich Nietzsche would have remarked, "Controversy is foreign to my nature." I have no doubt that there are many other officers who are going to make reply to the article named above, and probably more conclusively than I; but there may not be, and a few points brought out (if not *made*) are worthy of a voice from the other side.

Commander Fisher states baldly at the beginning of his thesis that the only reason for the establishment of corps is a desire for power on the part of some specialists, and declares that all authority now enjoyed by these segregated corps specialists has been in some way craftily stolen from the line, or commanding corps. Now it is a fact that every corps, not excluding the line, has its normal percentage of scatterwits; and I have during the past sixteen years heard the idea advanced that staff officers under certain conditions should have more absolute control than they now have; sometimes these recommendations being carried to the absurd limits which have apparently stirred up Commander Fisher to write about it. It is a rash proceeding at best, however, to judge the value of any large body of workers from the noise made by their inevitable foolish five per cent. There may be some staff officers who are rabid for "power"—I cannot think of any just at present, but I can remember some now happily no longer with us. But of the staff officers who are regarded by staff and line as efficient, I cannot think of one who has any other ambition than to be the best possible servant of the navy. To accomplish this ambition, a certain amount of administrative authority is at times requisite, but there is a vast difference between administration and command, a difference apparently unrecognized by Commander Fisher. In fact, the difference is so marked that in many cases I have personally encountered, the ability of the line officer in command has been actually diminished if not nullified by circumstances which forced an undue amount of administration and administrative duties on his already overloaded shoulders. As far as this administrative authority is concerned, it is necessary and desirable only for one reason, and that a compelling one—you cannot hold a man responsible for anything over which he has no authority. Would Commander Fisher expect the commanding officer to reconcile his ship's statement of differences from the treasury? The best answer to this assertion as to the "only reason for corps" is to deny it absolutely as erroneous. In my own case, which is the one about which I naturally know the most, there is no line officer who can truthfully state that I have ever attempted to usurp

one iota of his authority although there are many who have at times honored me with special duties entirely outside my normal ones involving a high degree of administrative authority and at times actual if not theoretical command. I do not base any assumption that I would amalgamate into a decent line officer on these circumstances, and I would combat anyone who attempted to use them as argument for amalgamation. I haven't time to be a good line officer, although I am an 8 to 10 knot navigator, was at one time one of the most successful spotters in the navy, have trained guns' crews who wore E on their sides, and have been powder division officer and have stood watch at sea and in port. I realize that these duties are but excrescences on the duty of the line, which is command and winning battles. That Commander Fisher is viewing only the similar excrescences of staff duties is witnessed by his remark about "specializing in disbursing pay."

The paper states that corps make for laziness in the line. Perhaps. But I have never seen a successful, lazy line officer. Nine times out of ten, when the line officer isn't actually working with his tools and his hands, he is studying how, or talking shop or thinking along his lines—in short he is putting all his time in on his profession. So are we of the staff. Naval duties are not stationary. The duties of my corps no more resemble their duties of fifteen years ago than a flying boat resembles an Old Town canoe. This very feature makes the three-year detail ridiculous. Is there any line officer who would contemplate leaving his profession for three years without qualms about the difficulties he will encounter on coming back? So with all of us. A supply officer whose detail ended in March, 1920, now back at line work would have a hard time. In March, 1923, when he returned to supply duties he would have a worse one, for the greatest bloodless revolution in history has taken place in the finances of the U. S. Government and every word, comma and semicolon in the Budget Act has an immeasurable effect on all fiscal branches. The accounting system has undergone changes no less vital, the storekeeping system has been overturned; and why? Simply in order that fiscal officers may be better and more economical servants of the country which in our case means the navy; and to the supply corps, "the navy" translates into all other corps, headed by the line, all enlisted men and civilian employees. I think I am able to learn new things with fair rapidity—average at least. It takes all my time keeping abreast of current advances in the art and science of my profession. If I left it for three years or one year, I could never get back to it satisfactorily.

The ranking officers of the supply corps are not, as the paper states, "doing administrative work similar to that performed by line officers," etc. They are doing administrative work which is far removed from that done by line officers or *ever* done by line officers. They are doing *commercial work adapted to military needs* and there is no conceivable psychology more unfitted to commerce than that of the kind of line officer who is a successful commanding officer. And the converse is also true—that is why no amount of study could make anything but a makeshift line

officer out of the truly successful staff officer—his mental processes swing in different orbits, around the common center, operations of the navy. And while the officers attached to the Bureau of Medicine and Surgery do not spend their days writing prescriptions, a little investigation will convince Commander Fisher that the senior officers of that corps at hospitals are doing a very great deal of "specialist" work as consultants and as operators.

Which brings me to the assumption of the article that all authority now exercised by the staff has been taken from the line. This can also be flatly denied, since the issuance of G. O. No. 53. No authority in any line which the line ever handled is now in the hands of the staff. The rendition of fiscal and financial returns by the commanding officer cited, ceased when the fiscal officer became an officer. The captain once rendered returns because the purser was *not in the navy nor the government service in any capacity* but was simply a civilian contractor.

A great many of the arguments used are now rapidly disappearing, for instance the accounting duplication. Naval accounting has got past the bookkeeping stage and is now a science as well as an art. There seems to be no obvious reason for the detail of an officer of the supply corps to each bureau—does it matter in which room your servant works, as long as your work is done? The "control of various appropriations" is a fleeting matter—soon the number and diversity of those appropriations will begin to melt away, and eventually, as sure as rent day, there will be but one navy appropriation with a few limiting provisos.

One thing which is forecasted is that the supply corps will soon and inevitably demand its own enlisted personnel. This is a rather startling conjecture to me at least. I have always had best results in training men who had been taught discipline first by the men who specialize in discipline—the line. Moreover, I would hate to think that the time will ever come when I will find it impossible to have a yeoman broken back to his former deck rating of sea. 2c., when he needed it, without discharge and reenlistment. An enlisted man who has been handled and brought up by good line officers is the only material really worth spending time on in supply departments afloat or ashore—but it takes more than an occasional three-year detail before an officer is fit to train him in a supply department rating.

Navigators, gunnery officers, engineers and first lieutenants have this thing in common, which is the logical reason for their all being line officers—their business is to get the ship into battle, to fight her in battle and to win the battle, and their every activity of discipline, cleanliness, shooting the sun or overhauling the condensers is toward that object. Pay, commissary, clothing, accounting, issue of supplies (not requisition, except as regards the final, legal form required by statute. *Vous autres chevaliers de la garde* must ask for what you want) are all different, from each other and from the dozen or more other unmentioned duties of the supply corps. BUT, they are all commercial and fiscal, and so must be together.

Paragraph 33 of the article reads: "No bureau wants to be the indirect cause of increasing the number of officers in a corps, centering in some

other bureau, and thereby decreasing their own relative authority . . ." Brothers, brothers! Are we like that? Most of us? *Any* of us except the fool five per cent? I had thought the Act of August 29, 1916 stepped on that really treasonous self-seeking between corps . . . . .

"The power to direct and control flows only to the man who by general experience knows how." Right, a thousand times right! And the corrolary is that the man who tries to direct and at the same time retain cognizance of all the details better left to specialists cannot direct. The best commanding officer under whom I have ever had the honor to serve—and I have been unusually fortunate in regard to commanding officers—once told me that "the hardest thing about my job is to remember that I am no longer the executive, and when I was executive it is a wonder the engineer didn't poison me for the way I interfered." That particular commanding officer is the only line officer of my acquaintance who had studied supply work sufficiently to direct details—and he is also the only one who consistently and inevitably never did so direct the details but left them entirely to me, his specialist, saying nothing when things went right, "crawling my hump" if they were only right, instead of *best*. A specialty which demands all of one's waking, working, studying time cannot be made a detail; and the specialist officer is like a virgin in one respect—he's entirely specialist or he is none at all! The days are past when "getting by" will do in anybody's job in the navy; and the man who must "get assistance from others who have"—which means, be educated by his yeoman—can never hope to do more than just barely "get by."

"Line officers have, in the past, controlled the navy . . ." yes, and thank the Lord they still do! Never, I hope, will the main mission of "getting there fustest with mostest ships" be subordinated to any form of theoretical control! But when a line officer has to lose sight of his main mission, even for a brief period, he is as bad as the staff officer who loses sight of *his* mission—deadwood, a hybrid, a salary-drawer. Command us and we serve, gentlemen of the line. But when it comes to the comptroller, or the auditor, or manufacturing, or cost accounting or purchasing or storekeeping or transportation or chartering or curing dysentery or planning a balanced ration or locating raw materials or keeping within statutory limitations of appropriations and still getting the work done—unless you put in *all* your time at it, you must do it in something less than the best and most economical and efficient way. Your job is too vital to the nation to have its *non-fighting* details hamper your attention.

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

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Life, regular and associate, 5487.
New members, 9. Resignations, 9. Deaths, 7:
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Lieut. Commander V. N. Bieg, U. S. N.
Lieut. Commander H. W. Hoyt, U. S. N.
Lieut. M. H. Esterly, U. S. N. R. F.
Ensign W. F. Cleveland, U. S. N. R. F.
Mr. Paul Crocker.

Practically the whole service receives the benefit of the PROCEEDINGS yet many officers, who read it monthly, are not members and therefore contribute nothing to the support of the Institute. Members are requested to urge non-members to join. Publication costs are now so high that the Institute is carrying a loss. The cost, per member, however, decreases with an increase in membership.

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Index to Proceedings

The attention of readers of the PROCEEDINGS is invited to the classified analytical index for numbers 101 to 200 inclusive, which is noticed under "Publications." This is a most complete index, which has been prepared at considerable expense in order to make readily available the information contained in both the articles and the notes of these issues. Only a limited number of copies are being printed. Price, bound in cloth, $2.35; bound in paper, $1.85.

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The Institute desires articles of interest to all branches of the service, including the Reserve Force. Attention is invited to the fact that the submission of articles is not limited to members, and that authors receive due compensation for articles accepted for publication.

All articles and discussions submitted by persons belonging to the navy for publication in the PROCEEDINGS must be in duplicate, one copy being signed by the author, which will be submitted to the Navy Department when the original is published, as required by General Order No. 46, of May 20, 1921.

Reprints of Articles

The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article is submitted. Twenty copies of reprints are furnished authors free of charge.

Illustrations

Authors of articles submitted are urged to furnish with their manuscript any illustrations they may have in their possession for such articles. The Institute will gladly co-operate in obtaining such illustrations as may be suggested by authors.

Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Notice

Whole Nos. 6, 7, 10, 13, 14, 15, 17, 144, 146, 147, 173, 215 and 217 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 75 cents per copy.

ANNAPOLIS, MD., October, 1921.

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PROFESSIONAL NOTES

PREPARED BY

COMMANDER F. M. ROBINSON, U. S. Navy

GENERAL ARRANGEMENT

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FRANCE

CRUISER DESIGN.—One of the most significant items in the new French naval program is the decison to build a larger type of cruiser than any planned during or since the war. It may be recalled that in 1918-19 M. Leygues, in the program he put forward as Minister of Marine, stated that the 1912 building plan had left France destitute of light cruisers for scouting and other duties, and he therefore proposed six vessels of 5000 tons, 30 knots speed, and armed with eight 5.5-inch guns. Then in 1920 M. Landry, the new Minister of Marine, adopted the six cruisers as part of a program which he framed, but a slightly larger displacement, 5200 tons, was scheduled for them. Now, under the vigorous administration of M. Guist'hau, the matter has entered upon a new phase, and sanction has been obtained for the construction of six armored vessels of 8000 tons with a speed of 35 knots, and armed with a new pattern of 194-millimeter (7.5-inch) quick-firing gun.

The explanation given of the decision to make this increase is that the Germans are about to begin a series of large, fast armored scouts of a nominal displacement of 6000 tons, which might easily outclass the 5200-ton vessels of the old French program. It is entirely natural that our Ally should not wish this to come about, but the fear would seem to be rather exaggerated. Under the Peace Treaty, Germany has the right to build cruisers up to 6000 tons, but only in replacement of ships allowed her under the Treaty, and as the latter include only six light cruisers it follows that she could not build more than that total even in the remote contingency that all were to be replaced at the same time. It seems more reasonable to conclude that the French Ministry of Marine has been influenced to a great extent by the new types evolved towards the end of the war in England and America, and now represented by the *Hawkins* and the *Omaha* respectively. With the launch of the *Effingham* on June 8 at Portsmouth, all four of the cruisers in the British series of 9750 tons, 30 knots, and seven 7.5-inch guns are in the water; and with the launch of the *Cincinnati*

on May 23 three of the ten American vessels of 7500 tons, 33½ knots, and twelve 6-inch guns are also afloat. Whether Japan is building such large light cruisers is uncertain. It was reported at the launch of the *Nagara* at Sasebo on April 25 that this vessel would be of 5770 tons, 33 knots, and armed with seven 5.5-inch guns.

If the French in their new cruiser design are chiefly concerned to follow the lead of Britain and America, they ought to know in their own minds what are the tactical uses to which their new cruisers will be put. The British *Hawkins* class was built for one purpose only, that of an ocean-going and ocean-keeping commerce protector, strong and fast enough to account for any such corsair as the *Emden*. The battle cruiser, originally built for such a duty, among others, was not utilized for it in the war on account of being more urgently needed elsewhere, but if she had been so used, in conjunction with light scouting craft, the commerce raiders could not have survived any more than did von Spee's squadron when the *Invincibles* were directed against it. There is no need now to repeat the *Hawkins* type. If this was done the ships would certainly attract to themselves other duties, they would be followed by larger craft abroad, to which in turn we might have to reply with still larger vessels—until in time the original conception was lost sight of. So there would be repeated the great mistake of the armored cruiser and large protected cruiser, which grew and grew to an extent probably never foreseen when they were originated in the nineties, but which did nothing of note in the war. It is unsound policy to go on building ships, each new type increasing in size and cost, without knowing the use to which they will be put in the event of war.—*The Army and Navy Gazette*, 27 August, 1921.

FRENCH NAVAL TOPICS.—Although the old gentlemen of the Senate, in their hurry to get out of Parisian heat and fever, forgot to vote the naval program, the business-like Minister Guist'hau is acting with as much decision and foresight as if that indispensable formality had been complied with, in the knowledge that "*le temps perdu ne se regagne jamais*" in the shipbuilding line, and that the value to France of the remarkable fighting units designed by the *Section Technique* depends for a great part on the speed and efficiency that will be produced by their construction. Orders have been given to conclude the *Thüringen*, *Prinz Eugen*, and *Béarn* experiments before the end of the current month, so that all practicable data may be embodied in the new vessels, and a "*rapport d'ensemble*" made upon the scientific progress revealed by the comprehensive tests now being carried out in Paris, as well as in the arsenals.

A new development in the redistribution of the French fleet has taken place with the appointment of Rear Admiral Lequérré (57 years of age) to command the recently-formed "*Division de la Manche et de la Baltique*." This distinguished flag officer, who has just relinquished the post of *Directeur Militaire du Personnel* at *Rue Royale*, will have under his orders a numerous though heterogeneous force, modest enough so far as up to dateness and ballistic power are concerned, but adequate for the purpose for which it is intended, viz., the possible blockade of the coasts of Bocheland. It will comprise three 18,000-ton ships of the *Voltaire* class (*Voltaire*, *Diderot*, *Condorcet*) that received a few war modifications and improvements, and the *croiseurs cuirassés Hugo* and *Ferry* (yet good for 20 knots), together with over 40 destroyers and avisos, without mentioning the underwater and aerial craft of the Cherbourg center that are being placed on something like war footing. The above-mentioned battleships and cruisers will, for some little time yet, need the care and nursing of the Brittany arsenal if they are to make good the defects that have developed during the last two years of complete neglect which they spent in the Toulon naval cemetery. In waiting for possible emergencies, Admiral Lequerré will keep up the era of active training for war inaugu-

rated in the northern waters by Admiral Salaun; all the more so, as he will have the hearty co-operation of the Brest and Cherbourg Prefets Maritimes, Admirals Schwerer and Barthes, who have revealed themselves as true men of action and are alive, like most of their colleagues are, to the offensive rôle naval bases will play in future contests. The long spell of naval stagnation along the Breton and Norman coasts has come to the end. As commanded by sound logic, the *Marine Française* is henceforth to display its greatest training activity in the proximity of its chief recruiting centers.

This French naval concentration in the North, which is the sign of a new turning in the maritime policy of the republic (and also a proof of France's inflexible will that Bocheland be made to repair and to disarm), will have the effect of weakening France's position in the Mediterranean, and it is implicitly a mark of trust given to our "Latin sisters." The latest Ministerial declaration in Rome insists on the importance of maintaining the naval equilibrium in the Mediterranean, and the relative position towards France (which is something like equality of forces) which the Italian Navy has acquired as the twofold result of constructions made during the war and of the 1914-21 stagnation in French yards. The seven 24,000-ton battleships of Admiral Salaun will have a ballistic superiority over the dreadnought fleet of the peninsular navy, but the latter will enjoy distinct advantage for cruisers and *poussiére navale*. At the same time, it is realized that since the war the constituting elements of the command of narrow European seas have been changed. Neither the gun nor the torpedo will rule Mediterranean waters. When strategic conditions are examined, and actual plans and preparations taken into account, the biggest factor to be considered will be that of the aerial bomb.

Moreover, for the present, at least so far as contests on the high sea are concerned, the Mediterranean supremacy is in the hands of Great Britain, who, besides controlling the gates and central passages of the Middle Sea, can at any time she pleases, array in Southern waters battle forces strong and efficient enough to throw into insignificance the united French and Italian squadrons. Armchair critics, as instanced by the recent confused debate in the Paris Chamber, are apt to forget that an important consequence of the suppression of the Boche armada has been to restore to the British fleet complete freedom of movements, and to make her the uncontested mistress of European waters, and especially of the Mediterranean, where the foresight of British admirals and statesmen made sure of the controlling positions of Gibraltar and Malta, without mentioning more recent strategic acquisitions.

The Italian Kingdom is competing hard with France in the game of governmental instability, and it looks as if the *Republique Française* would soon be in danger of losing her time-honored supremacy in that respect. The latest Roman Ministry has just made interesting declarations on naval policy—a point which, it will be remembered, was totally overlooked in the *Declaration officielle* made some eight months since by the Briand Cabinet. This shows naval questions to be more popular in Italy than they are in France, and no wonder, since the peninsula has, relatively to its area, a longer seaboard than France, and, besides, has no deadly peril to fear on land since the disruption of the dual monarchy. Italy is thus more at liberty than she ever was before to devote her attention and resources to forward her maritime welfare and strength. An amusing proof of the genuine interest the people of the peninsula entertain for the sea was recently afforded by the blazing indignation that swept like wildfire over the whole land at the rumor that the "perfidious" Paris Government had graciously presented the Belgrade Court with the battleship *Vedette*. Deductions were obvious; and the announcement was, in a measure, true. Paris journals, and perhaps also the Paris Admiralty, sought an excuse in the fact that the "battleship *Vedette*" belongs to the

motor launch class of *cuirassés*, only carries one or two pop-guns, and is manned by a dozen warriors.

It is not surprising that, despite the oft-repeated affirmation in Parliament as to the command of the Western Mediterranean being the *raison d'être* of the *Marine Française*, many Gallic experts should persist in opposing a purely Mediterranean policy as being a foolish and even a suicidal course to adopt for France. Under the new conditions of warfare, they point out, the Mediterranean might easily turn out to be a naval mouse-trap, where the belligerent fleets would be imprisoned, and without influence on the ocean war game that alone will count in the end. They deride the prevailing notion that safe communications between France and Algeria depend mainly on the numerical and ballistic superiority of the Gallic fleet over the Italian, and sarcastically invite *les Méditerranéens* to examine anew the strategic possibilities of their favorite sea in the light of the exploits of Boche pirates, and, also in the light of recent submarine and aerial developments. The transportation of the *Corps d'armée d'Afrique* from Algeria to France, and the successful convoys the Paris Admiralty organized from Port Said to Marseilles, are valueless "precedents" that find their explanation in the bottling up of the Austrian fleet in the Adriatic, but that will never be repeated in Mediterranean warfare. The limited space between Corsica, Sardinia, Sicily, and the Balearic Islands has every chance of becoming a "no-man's land" so far as large surface ships and liners are concerned. The vulnerability of Toulon to aerial attacks and the precarious situation of a fleet that would be locked up in that cramped-up arsenal are further arguments against a policy of the Mediterranean concentration.

Indeed, the problem of safe communications between France (or any other power) and her colonies is not one that can safely be dealt with on superficial make-believe lines without taking into account the possibilities of the new methods of warfare as revealed by the war; as revealed also by recent scientific discoveries. Only those who choose to shut their eyes to these *faits nouveaux* can picture a state of affairs in which convoys could safely proceed along the direct route from Provence to Algiers or to Bizerta. The Atlantic route from the many ports of the Bay of Biscay to the several harbors now being created or enlarged on the Moroccan coast might be safer for obvious reasons. There now remain the submarine and aerial routes. Gentlemen of *La Zeune Ecole* trust to underwater *invisibilite* and apparent *invulnerabilite*, and on paper have already brought to life splendid fleets of *transports sousmarins*, although systematically ignoring the developments which mining blockade and aerial patrolling will receive in the contests of to-morrow. True, the submarine *Deutschland* safely reached neutral New York, but it is forgotten she would have no chance whatever of entering that harbor had it been screened by minefields of the latest type. As to aerial communications, it will not be so easy to intercept them; but then, compared with surface ships, the biggest airplanes now designed are nothing but mosquitoes, and along the aerial routes there can fly to France no reinforcements and supplies of any great importance. This is the conclusion of all *chercheurs:* true value and safety reside in the large capacious armored ship rendered as insubmersible as possible.—*The Naval and Military Record*, 10 August, 1921.

NAVAL PROPAGANDA.—In view of the success of the maritime manifestations at Havre, Rouen and Dieppe there can be no doubt that popular opinion in this country is solidly in favor of creating a more powerful navy, consolidating the merchant marine, and constructing the docks and other equipments necessary for the new fleets. Those manifestations followed upon the Congress on Inland Navigation at Rouen and on conferences by the *Ligue Maritime*, which carried out all arrangements. There were races of motor boats and gliders from Paris to the sea, and very high speeds

were accomplished by the Farman and Lambert Gliders, which appear to be forerunners of a type of craft that may be extremely useful for rapid transport on shallow colonial rivers. The President of the republic visited Havre, where he was shown the works in progress under the vast program of harbor extensions, for which it is hoped to raise the necessary funds by public subscription. That, indeed, was the object of the manifestations, for it is very difficult to get money from sources that are almost exhausted, and the only hope of success lies in giving a national character to the program which will enable Havre to cope satisfactorily with the present heavy traffic. The President passed in review a squadron in which the British and American navies were represented. He then went to Rouen and saw under construction the docks that are to make the town a distributing center for the inland waterways as well as for Paris, which, as soon as the work of deepening the Seine is completed, will regard Rouen as an advance port. Finally, the President paid a visit to Dieppe, where improvements to the fishing fleet claimed his attention, and he inspected the new steamer *Versailles*, which is to be put on the Newhaven-Dieppe service, and is expected to effect the crossing in less than three hours.—*The Engineer*, 5 August, 1921.

AIR AND SEA POWER.—In democratic countries like England and France, but specially in France, the spring of progress and efficiency in any branch of war preparation is to be found in the overwhelming demand of public opinion for a national effort in those directions. This means that before any great reform can be assured acceptance and to live, the education of the people must be effected and their consent obtained. Hence, the parallel campaigns now being made in France and in England in favor of aerial expansion. English experts, looking far ahead, are fully alive to the interdependence of aerial and maritime power, whilst Gallic military and aerial authorities who since the war have been so fond of living over again the contests of the world conflict and of fighting anew the battles with the improved weapons of to-day do not entertain the least doubt about aerial supremacy being for France a life-and-death matter, since it would enable her to ensure the maintenance of peace to which she is perhaps more attached than any other nation, for tangible and visible reasons.

The misfortune is that Jean Crapaud, our man in the street, or rather in the fields, feels on his robust shoulders the ruins of the devastating war, and the burden of a huge standing army and of a costly fleet, and not unnaturally he looks askance when patriotic deputés, having an eye on Germany, earnestly propose saddling him also with a third *armée de l'air* and *Budget de la Guerre aéronautique*. The financial question, indeed, cannot be ignored. Our Republic—before the war the banker of the world—has been thoroughly depleted of her gold. Her national debt exceeds 320 milliard francs, her annual budget is 55 milliard francs, and her annual deficit some 20 milliard francs! This is only one of the aspects of the profits victorious and "*Imperialistic*" France has derived from the war.

And yet, as France means to live at all cost, aerial expansion may be looked upon as a necessity of to-morrow, and also as a certainty, for before many months have elapsed public opinion will demand it, as may be judged from significant symptoms. Not only is the Rue Royale Admiralty preparing a definite *programme d'aéronautique* on up-to-date and comprehensive lines, but aerial questions are prominent in the press and in the lecture halls. The great aeronautical inventor and constructor Michelin, Député Fonk, Baron de la Vaulx, and several others are touring our great cities and preaching the gospel of aviation to enthusiastic crowds. Ingenieur Ader, the originator of the first flying machine, is multiplying his appeals and warnings to Président Millerand and to Premier Briand, and his lurid pictures of Paris reduced in a few days to cinders by the possible German bombardments of to-morrow nobody derides, for most

Frenchmen have had a taste of what aerial bombardment means and instinctively feel what is in store for to-morrow. Admiral Guépratte, of Dardanelles fame, though a believer in the battleship, has again and again stated his opinion that he who commands the air will command the sea also and such views are shared by our leading admirals.

Numerous are the French partisans of a *Ministere de l'Air*, equal in importance to the War and Marine Ministries; but the truth is that both the army and navy want to have their own aviators. When Colonel Fabry recently proposed in the Chamber the creation of a unique Ministére de la Défense Nationale, englobing the land, sea and air service, ex-Minister Landry retorted that a reform of that sort would mean the end of the French Navy, that would fall under the sway of military men unacquainted with sea matters, and at all times ready to economize at the expense of the fleet.

Experience during and since the war has shown that the aviation service cannot be worked on economical lines, though avions may be termed economical weapons considering their tremendous individual capabilities. There is the incredible wear and tear to be contended with, and rapid evolution that causes *avions de chasse et de combat* to become obsolete after a few months' service. This explains why aerial machines cannot, as in the case of ships, be constructed long in advance and be stowed away in reserve for eventual use. So, the capabilities of the industrial plant, rather than the number of units actually ready, are the true criterion to the aerial possibilities of any power. Germany, in 1918, could easily turn out 2000 fully equipped avions per month. Her plant, if anything, has improved; she is believed to be well to the fore in the designing of gigantic sea and land bombers. France, that constructed over 50,000 avions in the course of the war, produced, in 1918, 2800 avions per month, and 4000 motors; but disorganization and waste have since brought her down below the level of Great Britain and even of Italy. To restore France to her former position, to make her potentially first by the use of foresight in the organization and utilization for war purposes of the aerial assets of the country is officially the program of both the Paris Admiralty and War Office. Considering the difficulties in the way, the task is well-nigh superhuman, even with stability and competence at the head, especially as Germany, being freed from the trouble and expense of keeping huge armies and fleets, will seek consolation in a supreme "commercial" fleet of the air.

Those experts who, patiently and methodically, and in the light of war experience, have tried to ascertain the aerial needs of the navy have come to conclusions rather unpalatable to gentlemen of *la jeune école* who have all along been regarding aviation as being *l'arme économique et éfficace par excellence*. Fragile and short-lived are the best aerial weapons, and their rate of military utilization is extremely low. For instance, out of the 45 *avions de combat*, picked machines and picked aviators, which were entrusted with the aerial guard of Paris, only five could be relied upon to patrol at a time, and, moreover, postwar experiments with better machines have confirmed the view that aviation is for the present an essentially fragile and unreliable weapon, viz., the British raid from England to Egypt, the French Toulon-Bizerta and Toulon-Casablanca flights, without mentioning recent fleet exercises in England as well as in France. All-round robustness and seaworthiness are wanting; designs are always satisfactory on paper; the peculiar and hard requirements of sea service are the only point constructors overlook. The remedy will readily be found once constructors are required to be also practising aviators—and that day is coming. Our *ingénieurs d'aeronautique* are to be proficient in the handling of all types of flying craft.

The numerical strength of the aerial wing of the navy may be gauged from the fact that it will be expected to protect the coasts and colonies, as well

as the fleet at sea, besides providing a group of heavy bombers for offensive operations over European seas. The *aviation côtiere*, that comprised 1200 units in 1918, will be none too strong with 2000 seaplanes, as its duties will be fivefold, viz., to nip in the bud all attempts at bombardment or landing, to meet and repel aerial attacks, to hunt down submarines, to escort coastal convoys and to take an active part in fleet actions taking place in close proximity to land (which is invariably the case in all great battles). A comprehensive task will also fall to the lot of the *aviation d'escadre* that is just now being reorganized on nominal lines; viz., it will have to scout, to beat off aerial opponents, to bomb hostile ships, and also to control long-range firing—all duties that will not be performed without the assistance of many seaplane mother-ships and without some numerical superiority. Here the English policy is seen to have been far-seeing and wise. But it is in her heavy *escadres autonomes de bombardement* that the aerial power of the French Navy will find its most telling expression. As shown by the Prinz Eugen experiments, the bombs have been found that will destroy swiftly and economically any ship provided they happen to fall on a vulnerable point, and, indeed, considering the frightful details Constructor Michelin gives us of the effects of the latest aerial shells, it will be sheer folly for enemy ships to keep within range of the said French bombs that only await robust and reliable *avions de bombardement* to carry them. Up to the present the success of heavy marine *hydravions* has only been moderate in practice, though on paper great strides have been made. In the recent overland endurance test a single machine competed, the old Farman *Goliath*. Constructor Breguet, however, is making 2000-horse-power machines for over-Atlantic flight, and next year, if expectations are realized, French industry will give the navy the heavy seaplane bomber which it so badly needs, possessing radius of action and all-round robustness.

The studies and experiments which have given rise to the problem of the aerial bomb have led to the belief that aerial offence is to a great extent dependent on chemical progress. Whilst there is a limit to the weight of steel and explosive matter to be contained in aerial projectiles, there is practically none to the destructive power of chemically-loaded shells that do not need to penetrate armor, to blind, asphyxiate, poison, disarm, and kill crews in the best-protected warships.—*The Naval and Military Record*, 27 July, 1921.

GERMANY

WARSHIP DESIGNS.—In alluding to the "somewhat complicated system of flooding" involved by the arrangement of compartments in German capital ships, and to the well-organized method of supervision which obtained, under a special officer, whose sole duty it was to look after the trim and safety of the ship, Sir E. d'Eyncourt said there was no doubt that this resulted at Jutland in the saving of some of the very heavily damaged German ships which would otherwise not have reached port. Dr. Bürkner (formerly Chief of the Naval Construction Department at the Marine-Amt) dismisses this as a legend, and declares that "none of our capital ships, excepting *Seydlitz* and *Lützow*, suffered during the battle even the smallest loss of fighting efficiency through the inflow of water." This statement is at variance with German reports of the battle. Dr. Bürkner will find on inquiry that the *Derfflinger*, for instance, took in 3400 tons of water through damage on or below the water-line, and it would be absurd to pretend that this great volume of water had no effect on the ship's speed or maneuvering powers, both of which are elements of "fighting efficiency."

Sir E. d'Eyncourt thinks the Germans had considerable confidence in the stability of their powder, as their anti-flash precautions were far less elaborate than those taken in British ships. On this point, Dr. Bürkner writes: "The burned child dreads the fire, and after losing three battle-

cruisers at Jutland through inadequate anti-flash protection, the British constructors had every reason to try and improve upon their former methods. It is doubtful, however, whether structural measures alone can avert the danger of magazine explosions due to shell fire, mines, or torpedoes. A great deal depends on the manufacture of the powder, its packing, and stowage, and it was in this respect that long years of experiment had given us an undoubted superiority. Nevertheless, the magazine fires in *Seydlitz* at the Dogger Bank and in *Derfflinger* at Jutland showed us that we still had something to learn."

In his comparison of various British and German types, Sir E. d'Eyncourt said that the first British battle cruisers were commenced early in 1906, and that "the German reply to these was the *Blücher*, a ship of very inferior design." Hereupon Dr. Bürkner comments as follows: "The ship was in no sense a reply to *Invincible*, for England's decision to build dreadnought cruisers was known in Germany only when work on the *Blücher* had progressed so far that her armament and leading dimensions could not be modified. *Blücher* was simply a later development of the *Scharnhorst* class, and, within the limits of the design, a very successful ship. Her armor was far more extensive and no less thick—on the belt it was actually thicker—than that of the *Invincible*, and her underwater protection was not limited to the magazine spaces, as in the British ship, but was continued in way of all vital parts. *Blücher* had also a 5.9-inch armament, which the *Invincible* lacked, and her maximum speed of 25.8 knots, practically the same as *Invincible's*, made her the fastest large reciprocating-engined vessel in the world. The real though belated reply to *Invincible* was *Von der Tann*, and the Battle of Jutland proved the 'reply' to be quite satisfactory." One must admit the unfairness of comparing the *Blücher* with the *Invincible* class. She was probably the best and most powerful armored cruiser ever built, and much superior to the *Minotaur* or the U. S. S. *Washington*. The hammering she took at the Dogger Bank before going to the bottom revealed the staunchness of her protection.

Dr. Bürkner challenges the accuracy of the German speed figures given in Sir E. d'Eyncourt's table. According to the former, the trial speed of the various German battle cruisers was as follows: *Von der Tann*, 27.4 knots; *Moltke*, 28.4; *Goeben*, 28; *Seydlitz*, 27.9. As for the British vessels, the *Invincibles*, which antedated the *Von der Tann* by two years, made 25.3 to 26.2 knots; the *Indefatigable* (contemporary with *Moltke*), 26.7; the *Lion*, *Princess Royal* and *Queen Mary* (contemporaries of *Goeben* and *Seydlitz*) made 27, 28.3, and 27.8 knots respectively. Dr. Bürkner does not tell us whence he derived these British trial figures, and it would be interesting to learn whether they are correct. The *Derfflinger*, *Lützow*, and *Hindenburg* ran their speed trials during the war, when the deep-water measured mile, off Neukrug, could not be used owing to the danger of enemy submarines. The ships had, therefore, to be tried over the shallow mile in the Belt (114.8 feet deep), at much deeper draft than usual, and using inferior coal. All these unfavorable conditions naturally affected the speed results. *Derfflinger* developed 76,600 shaft horsepower, equivalent to 28 knots in deep water, though only 25.8 knots was actually recorded; *Lützow* worked up to 81,000 shaft horsepower, which should have produced 28.3 knots, and *Hindenburg* to 96,000 shaft horsepower, corresponding to 28.5 knots, the actual speeds being 26.4 and 26.7 knots respectively. It is claimed, therefore, that the German ships were not inferior in speed to their British contemporaries, though Dr. Bürkner admits that the former were handicapped by their limited use of oil fuel, and could not maintain the maximum trial speed for long periods.

Sir E. d'Eyncourt said in his paper that German battle cruisers have been often compared with much earlier British cruisers and referred to as

contemporary, when the German ships were designed after the British, with increased protection. Dr. Bürkner replies: "The plans for *Von der Tann* were prepared between August, 1906, and June, 1907; those for the *Moltke* and *Goeben* in the period April, 1907, to September, 1908; for the *Seydlitz*, March, 1909, to January, 1910; for *Derfflinger* and *Lützow*, October, 1910, to June, 1911; for *Hindenburg*, May, 1912, to October, 1912." He is indignant at the suggestion that British battle cruisers were designed for attack because of their superior speed, caliber, and weight of bow fire, and the German ships "for defence and a retiring action," because they developed a maximum fire aft. "It has already been shown," he writes, "that the best speed of the German battle cruisers was equal to the British. The choice of thick armor was far more an expression of the will to 'dash at the enemy' than was the British adoption of thinner plating, which necessitated keeping at long range, and the same is true of our selection of smaller caliber guns, whose efficiency falls off at long range more rapidly than that of heavier calibers. It is untrue that bow fire is emphasized in the British more than the German ships. As for the disposition of the five turrets in *Moltke, Goeben,* and *Seydlitz,* which permits a heavier fire aft than forward, this was governed solely by technical considerations. As the authorities demanded five turrets in each ship—a larger number than was carried by the battle cruisers of any other navy—it was necessary to superpose one of the turrets aft instead of forward in order to make room for the powerful machinery and boiler installation. No one thought of designing these for 'a retiring action.' It remained for British critics to make this suggestion, but they wisely omit to add that the *Neptune* and her sister battleships which have the same turret arrangement, were also built to fight a retiring action."

Turning next to Sir E. d'Eyncourt's remarks on German battleships, Dr. Bürkner writes: "Sir Eustace maintains that we generally followed in the British wake, and that, although the protection of the British ships may have been somewhat less, the German vessels had to meet the fire of heavier guns than the British did, so that relatively the protection was approximately equal. Everyone knows that Admiral von Tirpitz was repeatedly attacked before the war for keeping to smaller caliber guns. His policy was based on the assumption that our 11-inch and 12-inch guns had as good or better penetrative powers than the British 12-inch and 13.5-inch, and that our lighter guns could discharge three rounds a minute as against the British two, so that the greater volume of fire would compensate for the smaller effect of individual hits, and the weight thus saved could be applied to protection. It is true that the grounds for this decision were somewhat shaken by the unexpectedly long range at which the actions of the war were fought, but the Jutland battle did not in any way prove the principle to be wrong. Thanks to the excellent advantage that was taken of the higher rate of fire by our well-trained gunners and fire-control officers, the superiority of our guns and projectiles was exploited to the utmost in this battle."

In the further course of his article in *Schiffbau,* on the papers read by Sir E. d'Eyncourt and Mr. Goodall at the spring meeting of the Institution of Naval Architects, Dr. Bürkner demurs to the statement that Germany, generally speaking, followed England's lead in the development of the dreadnought type. This, he declares, is true only in so far as Germany, by gradually abandoning the broadside disposition of turrets in favor of an *en echelon* arrangement, and then, finally, adopting the center-line principle, did traverse the same ground that England had covered a year or two beforehand. This, however, was due not to any waiting for an English lead, but to the military demand that each squadron of eight ships, or at least each division of four ships, should consist of vessels homogeneous in general design and armament, to facilitate tactical maneuvers and the training of personnel. As under the Navy Law only two to three battle-

ships could be laid down per annum, the evolution of turret disposition was necessarily delayed, but as early as 1907, when the *Ostfriesland* design was under consideration, plans embodying respectively a diagonal and a center-line placing of the turrets were submitted by the Construction Department. As regards machinery, the adherence to reciprocating engines in the *Ostfriesland* class was due to the fact that three sets of these engines were found to occupy less room than a turbine installation would have done, and the final decision in favor of the former was taken after a careful survey of the advantages and drawbacks of the rival systems.

In every other respect, writes Dr. Bürkner, the statement that Germany followed England's lead must be contested. It is particularly untrue as regards armor; indeed, it would be more correct to say that in this feature Germany lead the way and England followed. For instance, the *Orion*, of 1909, was less extensively armored than the *Nassau*, of 1906; and it was not until the *Iron Duke*, of 1911, that England reached the ratio of armor weight to displacement which had obtained in the *Kaiser* class designed three years earlier. "Furthermore, the British copied us by re-introducing the 6-inch armament. Where they did not follow us was in the low position of the armor deck, the heavy armoring of the conning-tower tube, the provision of splinter bulkheads in the upper part of the ship, and in the isolation of the case-mate guns by splinter screens."

In claiming for Germany the rank of pioneer in the development of underwater protection, Dr. Bürkner gives some new and interesting particulars of what was done in this direction before the war. As early as 1905 experiments were initiated to determine the best method of protecting a ship's vitals against attack below water, and these were continued up to the outbreak of war. They involved the use of explosives against various models, including a huge floating target of 1700 tons. "We never heard that any other navy went in for similar experiments on a corresponding scale."

The writer refuses to accept the bulge as an epoch-making innovation. In its latest development, he says, the bulge is in principle similar to the German outer torpedo bulkhead but it gives, if anything, less protection than the latter, because in order to reduce the resistance to the water it has to be fined down very considerably at the extremeties. Of the German ships equipped with the modern system of sub-surface protection only the *Blücher* was sunk by torpedo. Nine others were damaged by underwater attack, but all survived, the following particulars being given: *Westfalen*, 1 torpedo; *Ostfriesland*, 1 mine; *Grosser Kurfürst*, 1 mine, 1 torpedo; *Markgraf*, 2 mines; *Kronprinz*, 1 torpedo; *Bayern*, 1 mine; *Moltke*, 2 torpedoes; *Goeben*, 5 mines; *Seydlitz*, 1 mine and 1 torpedo. In all but three of these cases the explosion occurred within the region of the torpedo bulkhead. Incidentally the list has a significance which Dr. Bürkner omits to mention. It shows that our destroyers and submarines took full advantage of their few opportunities for attacking German capital ships, and suggests that had the High Seas fleet spent more time at sea, the capacity of its units for resisting torpedo attack would have been put to a far severer test.

Dr. Bürkner challenges Sir E. d'Eyncourt to publish a list showing what British dreadnoughts received similar damage and how they fared. This is rather disingenuous, for Dr. Bürkner cannot be ignorant of the fact that the *Marlborough* was the only British dreadnought to be torpedoed in the war. The *Audacious* was mined, but whether her sinking was due to the leak caused by the mine, or to the mysterious magazine explosion which occurred some hours later, is a puzzle never likely to be solved. Had the German U-boats and destroyers exhibited a little more enterprise and hardihood, we might have obtained a better idea of the merits of the British system of sub-division. As it is, this point remains just as obscure as the tactical efficiency of the German battleships, which in the Battle of

Jutland were hurriedly withdrawn from action at the very moment when their offensive and defensive qualities were about to be put to a real test. Dr. Bürkner is on firmer ground when he questions the statement of Sir E. d'Eyncourt and Admiral Tudor that war experience had shown the capital ship to be less vulnerable to underwater attack than had been anticipated. "Both," he remarks, "have overlooked the peril which threatens the ship's hull through the development of the gun-torpedo."

The "somewhat greater metacentric height" which Sir Eustace attributes to German capital ships was, in fact, twice as great as that which had previously been accepted as the maximum consistent with seaworthiness. The German constructors certainly showed much boldness in this respect, notwithstanding which their ships proved remarkably steady. The worst experience they had was with the *Von der Tann*, which during a Biscayan gale in 1911 rolled 17 degrees. In no case were anti-rolling tanks fitted, the ordinary bilge keels proving quite effective.

Dr. Bürkner then proceeds to discuss in considerable detail the points of difference between British and German cruiser designs, to compare the respective building periods for typical types and classes, and to correct on more or less important points what he declares to be the inaccurate data presented by the British Director of Naval Construction. Although in certain places his comments are tinged with bitterness, the article as a whole is written in an impersonal and strictly technical style, and deserves careful study as the first and most authoritative exposition of German naval construction policy that has up to now appeared. In conclusion, Dr. Bürkner writes: "The development of man-of-war construction in Germany was not conditioned solely by the skill of the naval architects, or the efficiency of the national industry. The Navy Law, which alone made possible the steady growth of the German fleet, operated in some respects as a handicap on free technical development. The financial situation of the Empire, and the continual efforts of the Treasury to keep expenditure within the limits of the Navy Law, compelled us to forego experiments, and this omission might have resulted in the building of defective ships. For reasons both of domestic and foreign policy the creator of our fleet, Grand Admiral von Tirpitz, had to avoid the appearance of setting the pace in the evolution of types; while, on the other hand, the task of keeping abreast of British technical progress was rendered most difficult by the secrecy which the British naval authorities practiced with such success. Despite these drawbacks, German naval designers and builders can look back with satisfaction on their work, which in a few decades had reached a standard of quality equal, and in some respects superior, to that of the premier shipbuilders of the world. This fact cannot be eliminated by speeches such as those delivered at the Institution of Naval Architects on March 16."—*The Naval and Military Record*, 3 August, 1921.

WON'T LET SCHEER GIVE TALK ON JUTLAND FIGHT.—Following out its policy of squelching reactionary rhetoric the government has forbidden Admiral von Scheer, the last chief of the German High Seas fleet, to deliver an address on the Battle of Jutland in Constance, local workingmen's organizations having let it be known that they were determined to break up the meeting at which the Admiral was to speak. Government bars are also up against General Lettow-Vorbeck of East African fame, who is forbidden to deliver lectures or war talks until further notice. Local authorities have prohibited a talk before the Dresden Civic Council by Major Gen. von Wrisberg on the question of "war guilt," giving as their reason that "the ensuing discussion or demonstrations might tend to bring the Constitution into contempt or glorify the foes of the republican form of government."

The government war on uniforms has brought about some embarrassing incidents. In various parts of the country enthusiastic Republicans, pre-

sumably radicals, have caught lone members of the Reichswehr in uniform and proceeded to beat them. This has forced President Ebert to promulgate yet another ordinance, this time "in deference of the Reichswehr against attacks." The President writes:

"The recent political excitement is regrettable. It has led to various cases of members of the Reichswehr being attacked on the streets without reason. Unfortunately, no difference was made between uniformed members of the Constitutional army of national defence and supposedly provocative political foes. A soldier is a citizen in uniform, representative of the Constitutional armed force. To respect him as such is a commandment of self-respect for the people."—*N. Y. Times*, 7 September, 1921.

U-BOAT CAPTAIN SEEKS TRIAL.—The *Abendpost*, of Leipsic, to-day says that Lieut. Commander Patzig, who commanded the German submarine which sank the British hospital ship *Llandovery Castle* during the war, and who is now in South America, has declared his intention of returning to Germany and surrendering himself for trial by the Leipsic court. The newspaper says that Patzig will surrender himself because he asserts that he, and not Lieutenants Ludwig Ditmar and Johann Boldt, was alone responsible for the act.

Both Ditmar and Boldt were sentenced to four years' imprisonment.—*N. Y. Tribune*, 7 August, 1921.

SHIPBUILDING IN GERMANY.—Many conflicting accounts have appeared in the British Press as to the position of the shipbuilding industry in Germany. It has been stated that the German shipyards are in a flourishing condition, that work is assured for a number of years to come, and that large profits are being made. The amalgamation of steel-works and shipbuilding yards, resulting in lower working costs through the delivery of materials to the shipyards ready for immediate erection in standard ships, has been emphasized, and attention has been drawn to the fact that most of the German shipbuilding companies have largely increased their capital.

The position is somewhat obscure, and the Germans are refraining, so far as possible, from publishing information which may lead the Entente countries to form estimates of the ability of Germany to pay the Peace Treaty indemnities. Following the revolution in 1918, conditions in the German shipyards were chaotic. The workmen got entirely out of hand and, among other things, abolished piece-work. Activities were impeded for want of materials, and great uncertainty existed as to the destination of ships building in connection with the conditions of the Peace Treaty. The London Conference of May, 1920, however, clarified the position, when it was decided that 245,000 tons of shipping then under construction were to be delivered to the Entente, and 100,000 tons would be allowed to remain in Germany. The position as regards supplies of materials has greatly improved; and German steel-makers are able to supply the requirements of their own shipyards, and, it is shrewdly suspected, to offer large quantities of materials for export through neighboring countries. The workmen are now reported to be working well and piece-work has been re-established.

There is undoubtedly a large amount of work in hand in the German shipyards at the present moment. Ship launches are of almost daily occurrence, the vessels ranging in size from 100 up to 12,000 tons; but if it is correct that the sale of the German mercantile marine in this country has glutted the market and, together with other causes, led to an unprecedented depression in British shipbuilding, is this not the cause of the present activity in German shipyards? Owong to the present depreciated value of the mark, German shipowners can work their ships and make a profit where British shipowners accepting the same freights would sustain heavy losses. With

this advantage and the determination of the Germans to reconstruct their mercantile marine, it is not surprising that German shipyards at the moment are reported to be full of employment while British yards are closing down.

That the German Government intends to make an effort to regain the position formerly held by its mercantile marine, and to render assistance to its shipowners to that end, is evidenced by the agreement concluded between the government and the shipowners in May, by which the government agreed to pay by way of compensation to the shipowners for the loss of their ships to the Entente twelve milliards of marks. These compensation payments are for the purpose of restoring the German mercantile marine to one-third its pre-war dimensions within ten years either by purchase or new construction, but at least 90 per cent of the vessels must be built in German yards. Two-and-a-half million deadweight tons are to be built within ten years from the 10th January, 1920.

Notwithstanding these factors, the Germans are not convinced that the shipbuilding industry in their country has a lengthy period of prosperity in view. The two and a half million tons of shipping to be constructed within 10 years under the compensation agreement represents only a small proportion of the total capacity of the German yards, which, in 1917, were estimated to have a post-war capacity of 750,000 deadweight tons per annum. Since that time existing yards have been enlarged, new yards have been commenced, and the Imperial dockyards turned over to merchant shipbuilding. No reliable estimate of the present capacity of the German shipyards is available, but it cannot now be far short of one million tons deadweight per annum.

Already difficulties are arising in connection with the compensation agreement. A building program was drawn up providing for the expenditure of the twelve milliard marks, but the ships now under construction involve an expenditure of double the sum allotted for this year. As a result, large numbers of shipyard workmen have been served with notices of dismissal. The men are now agitating for the period of the subsidy to be reduced, so that work can be proceeded with.

The condition of the Peace Treaty by which 200,000 tons of shipping were to be constructed annually for five years for the Entente to replace war losses, is not likely to be enforced during present conditions, and it is hardly conceivable that during the next few years British shipyards will not be able to supply all the tonnage that is needed for British and Continental shipowners. The Germans, therefore, have given up hope of any work under this condition of the Peace Treaty.

What emerges from the many statements which have appeared concerning the prospects of German shipbuilding is that the law of supply and demand, operating in Germany as in Great Britain, will decide whether the industry in Germany has a period of prosperity in front of it. German shipbuilders can build as cheaply as, or more cheaply than, British shipbuilders, and German shipowners can operate their vessels as economically as British. German shipyards can more than fulfil the contracts which German shipowners can place within the next few years, and, when a demand for ships once more arises, they will be keen competitors of British yards for foreign contracts. At the moment, however, the future of German shipbuilding is as uncertain as that of British, both of which depend on the recuperation of the industries of the world and the purchasing powers of all nationalities.—*The Shipbuilder*, August, 1921.

A NAVY IN THE MAKING.—The Germans have never taken very seriously the naval clauses of the Peace Treaty. They are convinced that these will become null and void with the passage of time, and if they have not already infringed them it is merely because the clauses in question have not yet begun to hamper the development of Germany's naval plans. Treaty or no treaty, it would be impossible for her to build many new warships at

the present time, and, this being so, she is indifferent to the embargo on dreadnoughts and submarines. Her immediate aim is to create the nucleus of a new staff and personnel organization which shall be capable of almost unlimited expansion when the proper time arrives. This was made clear during the recent debate on the supplementary estimates for the Reichsmarine. It transpired that the administrative and staff services at headquarters are absorbing no fewer than 1300 officers and officials—an extraordinary percentage for a navy whose total personnel may not exceed 15,000, including a maximum of 1500 officers and warrant officers, and whose main fleet is limited to six old battleships. Another significant fact that came to light was the extraordinarily large proportion of officers who have been assigned specialist duties, such as gunnery, torpedo, and navigation. In short, the German Navy as at present constituted is looked upon simply as a training school, as the nucleus of the real navy that is to spring into existence when financial and other circumstances permit. As an earnest of her future intentions Germany has just laid down at Wilhelmshaven a 6000-ton cruiser of a type specially designed for showing the flag in distant waters.—*The Naval and Military Record*, 3 August, 1921.

NEW METHOD OF CONCRETE SHIP CONSTRUCTION.—A new system of concrete shipbuilding developed in Germany in recent years dispenses almost entirely with wooden moulds. The ships are now built in a floating concrete dock whose walls correspond accurately to the shape of the hul to be constructed and provide the outer mould. Up to the present time, the system has been used only for the construction of river and canal barges. Wooden moulds are still used for the ends of the barge, being fitted on to each end of the dock, but no inner mould is required for any part of the vessel.

The concrete, which is a special mixture having a consistency sufficient to make it adhere even to vertical walls, is sprayed against the mould by means of compressed air. The effect of the spraying process is to press the concrete firmly against the mould, making it hard, strong and waterproof, and giving it an unusually smooth outer surface. By this method, walls can be built to the minimum thickness required, whereas by the old method of casting the concrete between moulds the walls usually were made thicker than was necessary for strength. The spraying system is also used for the construction of bulkheads and other interior walls.

The following advantages are claimed for the new method:

1. Simplicity, which makes possible an increase in the speed of construction. A river barge of average size, ranging from 800 to 1000 tons, can be built in six weeks.
2. Saving of wood otherwise required for moulds.
3. Saving of concrete, as the walls can be built to the minimum thickness.
4. Reduction in the weight of ships to a point only slightly greater than that of iron ships; concrete barges have about 90 per cent of the deadweight carrying capacity of iron barges of the same dimensions.
5. Lower cost of production. The concrete barges are from 20 to 30 per cent cheaper than iron barges.
6. Less power required for towing barges of this type, owing to the fact that the smooth outer surface minimizes resistance and prevents fouling.
7. The existence of a substantial and permanent floating mould and the elimination of launchings.—*The Nautical Gazette*, 13 August, 1921.

GREAT BRITAIN

NEW NAVAL CONSTRUCTION.—In the House of Commons, last week, the shipbuilding votes of the Navy Estimates were agreed to, after a singularly interesting debate. Among the credits passed were those for laying down four capital ships to replace eight vessels which are becoming obsolete.

The necessity of building these ships was made clear by Mr. Amery, Financial Secretary to the Admiralty in his introductory statement. The Battle of Jutland, he explained, established a new and much higher standard of efficiency for the capital ship than had previously obtained, and other powers had not been slow to take advantage of the technical lessons taught by that engagement. Japan and the United States are both at work on whole squadrons of new ships, individually superior in fighting power to the finest vessels of the British fleet, with the possible and solitary exception of the *Hood*. In contrast with this marked activity abroad, heavy naval construction has been entirely in abeyance here for five years, with the inevitable result that our relative position at sea is steadily declining. Thanks to the exertions we made before and during the war, and no less to the fact that circumstances have delayed the carrying out of the American program, our battle fleet momentarily retains its premier position; but its margin of superiority is shrinking so fast that it will have disappeared in a year or two, and from then onward the balance of capital ship strength will be against us. As that is a contingency which the naval advisers to the government could not view with indifference, they felt it incumbent on them to urge the laying down of a minimum number of new ships, notwithstanding the grave financial sacrifice involved by that policy. The program is certainly not excessive; it is doubtful, indeed, whether it can be considered adequate. If there were any prospect of our becoming embroiled with a great naval power, the vote for new construction would be demonstrably inadequate. But since, happily, there are no serious clouds on the political horizon, the Admiralty has done well, perhaps, to limit its demand this year to four ships only. Twelve months hence the whole position will have to be reconsidered; but by that time the Washington Conference will have been held, and whether its issue be favorable or otherwise we shall be able to see ahead more clearly than is possible to-day.

In deciding to adhere to the capital ship as the principal unit of naval strength, the Sea Lords of the Admiralty have taken the only course that was open to them as trustees of the national safety. Those upon whom devolves the responsibility of defending a great empire cannot be blamed for hesitating to throw away well-tried weapons, antiquated as they may appear to some, until an effective substitute has been found. In ten or twenty years' time the capital ship as we know her now may be as obsolete as the three-decker. But it is the business of the Admiralty to provide for national and imperial defence by sea at any given moment, not merely at some remote period. That is a point too often overlooked by enthusiastic theorists in the realm of naval strategy. We may be—probably are—on the eve of revolutionary changes in methods of conducting warfare afloat, but few who have carefully followed the "great ship or ——" controversy which has been waged since the Armistice will have the hardihood to assert that an absolutely convincing case has been made out on either side. On the whole, the balance of professional opinion has inclined toward the perpetuation of the capital ship, not because its limitations are unrecognized, but because it has so far held its own against all other claimants for supremacy. All who have paid the least attention to the subject are well aware of the possibilities that lie before submarines and aircraft. But whatever they may do in the future, the fact remains that they are not yet competent to replace the surface ship. As Viscount Curzon has opportunely reminded us, the Grand fleet was not prevented from going to sea on one single occasion by the operations of enemy submarines. That being so, who can confidently affirm that the existence of many British submarines and aircraft, unsupported by heavy surface ships, would deter a hostile battle fleet from putting to sea to attack our coasts or ravage our trade?

It is to be regretted that the Admiralty is not yet able to publish particulars of the four new ships, though there are no doubt sound reasons for its reticence in this respect. Still, on reading between the lines of Mr.

Amery's statement, it is possible to gain a rough idea of their essential features. Although described officially as "improved *Hoods*," it does not follow that they will be improvements on the arch-type in all respects. They are, as we know, to mount a heavier armament—16-inch as against 15-inch and as it is no longer a secret that the triple mounting is contemplated for these ships, they are evidently to be equipped with ten or twelve heavy guns apiece. The triple mounting, in addition to its tactical significance, has the advantage of economising weight, but however great the saving in that direction, it would not be such as to enable the designer to produce a vessel as fast and as well protected as the *Hood*, but carrying at least two additional big guns, on the same dimensions as that ship. This point deserves to be emphasized in view of Mr. Amery's remark that the dimensions of the new battle-cruisers "will be such as to keep within limits which will obviate the necessity of any larger docking or other accommodation being provided for them other than that already existing."

The *Hood*, it is well known, cannot be docked at Portsmouth or Devonport, and when in need of attention below the waterline, has to go to Rosyth, where the graving docks are just large enough to accommodate her. Now, it is clear enough that any ship designed to outclass the *Hood* alike in armament, protection and speed would have to be given increased dimensions. We conclude, therefore, that the *Hood's* successors will be inferior to her in some feature or other; and since the Admiralty's representative specifically refers to "improvements in the matter of protection and armament," the inference is that some sacrifice of speed has been accepted. Assuming this to be correct, it remains to be seen whether the official decision will be approved by students of naval warfare. Hitherto it has been a fundamental principle of British naval policy to design ships that are at least equal, if not superior, to foreign contemporaries, and any departure from this rule is certain to evoke criticism. It is not invidious to point out that whereas the *Hood* herself has a sea speed of approximately 31 knots, Japanese and American battle-cruisers now on the stocks are designed for 33 knots, if not more. It would, therefore be somewhat difficult to justify a lower speed in British battle-cruisers of still later design unless there are good grounds for the assumption that the tactical and strategic value of high speed in capital ships has been depreciated by war experience. In noting Mr. Amery's assurance that the new ships have been designed with an eye to existing dock accommodation we are unpleasantly reminded of one of the gravest indictments preferred by Lord Jellicoe with regard to our pre-war battleships. After emphasizing—in his book, "The Grand Fleet, 1914-16"—the disadvantage from which those vessels suffered owing to their narrow beam, which made them peculiarly vulnerable to underwater attack, he goes on to explain that "as each successive type of dreadnought was designed, our constructive staff were faced with the fact that if they went beyond a certain beam the number of docks available would be insufficient. . . . . It was one of the reasons which led to the German ships being much better equipped to withstand underwater attack than were our own." And, he concludes, "it is devoutly to be hoped that this lesson will be borne in mind in the future, and adequate dock accommodation provided for the fleet." We venture to echo this hope, without feeling too confident that it will be realized. In times of financial stringency there is always a temptation to adopt compromises, even when they involve risk. If the Admiralty were told that it could have money either for new ships or for new docks, but not for both, it would, in present circumstances, almost certainly elect for ships. But, in view of Lord Jellicoe's revelations, some official assurance that the all-round efficiency of our new battle-cruisers is not to be jeopardized by considerations of false economy would be welcomed.—*The Engineer*, 12 August, 1921.

OUR NEW BATTLESHIPS.—Now that we are definitely committed to a program of naval construction which includes four capital ships, interest naturally centers upon the design of these new vessels. Are we to be asked to build super battle-cruisers of an improved *Hood* type, costing anything up to £8,000,000 to complete and more than half a million a year to maintain in commission? If not, what is the alternative?

Cost is the dominant factor to-day in governing our naval establishments. The country can only afford—and will only consent to pay—a certain amount for naval defence. Whitehall must do the best it can with the means at its disposal. It is to be hoped that, with the object of being *sure* of getting the best possible value for money expended, the government has taken to heart the advice given by Viscount Jellicoe in "The Crisis of the Naval War."

"Governments," wrote the gallant Admiral, "are, of course, bound to be responsibility for the policy of the country, and policy governs defence, but, both in peace and in war, I think it will be agreed that the work of governments in naval affairs should end at policy, and that the remainder should be left to the expert. That is the basis of real economy in association with efficiency, and victory in war goes to the nation which, under stress and strain, develops the highest efficiency in action."

The *Hood* was the direct result of the more or less general capitulation of expert opinion to the speed fetish in the years immediately preceding the war. Until very recently most naval officers inclined to the opinion that an advantage of a few knots over an enemy was a sort of universal antidote to all the evils of warfare at sea. The earliest actions of the war—if we except the Falklands Battle, which was quite exceptional—tended to disprove this. Speed certainly is an advantage, but not when other essentials have to be sacrificed in order to obtain it.

This was realized by the Admiralty after the Jutland Battle and the plans of the *Hood* class, approved some two months previously, were modified accordingly. In order to give additional armor protection, the necessity for which was realized after the appalling losses sustained by our battle-cruisers, a reduction was made in the speed of the new ships. Yet the full lessons, not only of that fight but of the war as a whole, are only now being absorbed. It is obvious that our great battle-cruiser does not, in any way, represent the ideal capital ship. In fact we have already had it officially that if the Admiralty were preparing designs for a new ship they "would not design a *Hood*."

The *Royal Oak* class of battleship has the same main armament as the *Hood*, a more powerful secondary battery and much more efficient armor protection, yet is little more than half her size. Would it be to our advantage to have five improved *Royal Oaks* or three improved *Hoods*? Naval opinion has changed since it has had an opportunity to assimilate the facts revealed by the war. The sacrifice of speed in order to obtain greater smashing power and ability to receive greater punishment is now considered desirable on all hands.

It can be safely assumed that our four new capital ships will be real battleships and not battle-cruisers. They will embody the many lessons of the Great War. Increased gun power, increased armor and adequate protection against torpedoes and mines will all feature in their design. But they will probably be both smaller and slower than the "ideal" capital ship. If equal importance be attached to offensive, defensive and tactical qualities, the result, at the present time, would be a ship which the most wealthy power could not possibly afford in any numbers.

It is improbable that our new ships will exceed 30,000 tons displacement (nominal). On such a tonnage, in order to attain the speed of a battle-cruiser, it would be impossible to carry a sufficient armament and adequate protection. But if the speed be limited to about 23 knots, an extra turret

may be included in the design, mounting two (or more) 15-inch guns than the *Hood* and *Royal Oak* and bringing the total number of these heavy weapons up to ten, whilst enhanced protection may be provided. By the adoption of the triple gun turret, which, despite its several drawbacks, saves much weight and has given satisfaction in the Italian and American navies, it would be possible to mount even twelve heavy guns. That the caliber of the guns themselves will be increased is unlikely. We tried an 18-inch gun during the war and discarded it. Our 15-inch is the most powerful weapon in existence and much superior to the American 16-inch.

We can, then, reasonably forecast that our new battleships will be of about 30,000 tons, steaming at something like 23 knots and carrying either twelve 15-inch guns in four triple turrets or ten 15-inch in five twin turrets. They will have a powerful secondary armament, probably of 5.5-inch caliber, and battery of 4-inch anti-aircraft guns. Their armor protection will be very complete and of some 15 inches thickness on sides and big gun positions. They will probably have "bulges" to protect them from under-water attack, in addition to elaborate internal subdivision.

And—in another ten years they will be obsolete!—*The Army and Navy Gazette*, 30 July, 1921.

THE CANADIAN NAVY.—The statement that a training establishment for boys for the Royal Canadian Navy is to be established at Halifax on September 1st next is chiefly interesting by virtue of its symptomatic purport. Before the war Canada displayed an almost apathetic attitude towards the subject of naval defence. During the war she sent and maintained a magnificent army corps, but the service of her sons at sea, fine as it was, bore no sort of relative numerical proportion to her co-operation in the field. Now a change of spirit appears to be growing up in the Dominion.

There can be little doubt, we believe, that the unmistakable increase in national interest in naval problems in Canada is largely the result of the sea policy of the United States. We do not suggest that this is regarded with any sentiments of rivalry or distrust. But owing to the influence of contiguity it has brought home the meaning of naval defence to the people of Canada with a clearer perception than any material developments or academic discussions taking place thousands of miles away from their shores. The ships of the Canadian Navy have recently returned from a very extended cruise along the Pacific seaboard. Recruiting and volunteering for the Naval Reserve is said to be brisker to-day than during any peace period of Canadian history, which is good for that principle of imperial co-operation upon which our future naval policy must unquestionably be based.—*The Naval and Military Record*, 10 August, 1921.

SUBMARINE MONITORS.—It was a coincidence that the announcement that all the remaining monitors in the navy are to be sold was made about the same time that it was decided to utilize what have been hitherto called "submarine monitors" in the first flotilla of the Atlantic fleet. Yet the *M-3*, which has now been placed in commission for this purpose, bears a very different relation to other submarines than the monitors do to other warships of the regular types. The dimensions of the *M-3* are given officially as 303 feet long by 24½ feet broad, with a mean load draft of 15¼ feet. She is thus much smaller than the steam-driven vessels of the *K* type, but leaving out of account this exceptional class, the *M* type shows a consistent advance over all others in regard to size. Instead, however, of utilizing this extra weight for more speed or radius of action, the designers have put it into offensive power. One 12-inch gun and one 3-inch anti-aircraft gun are carried, as compared with two 4-inch or 3-inch guns in earlier types. Needless to say, this very considerable advance in gun-power places the *M* class well ahead of all others in any navy. But as

showing that the term "submarine monitor" is hardly appropriate, it may be pointed out that *M-3* has a surface speed of 16 knots, as compared with 17½ knots in the *L* type, and 9½ knots when submerged, as compared with 10½ knots. There is nothing like the big difference which obtained between the surface monitors and contemporary battleships, the former having speeds only half as fast as the latter.—*The Army and Navy Gazette*, 6 August, 1921.

BRITISH FLEET EXPANSION.—It is reported from London that the four battle-cruisers to be added to the British fleet will be armed with main batteries of ten or twelve 16-inch guns and will have a speed of 28 to 30 knots. Thus they would have an advantage of at least two guns over the six *Lexingtons* now under construction in this country. But the British cruisers will not be so fast by from three to five knots. They are to be heavily armored on deck and sides and further protected by torpedo-proof bulges; also stanchly compartmented to keep afloat under both shell and torpedo attack. The British ships are planned to be the most formidable of their type when they go into commission in 1924, at which time our six *Lexingtons* should be flying the American flag. On May 1 the *Saratoga* of this class was 22.4 per cent built and the *Lexington* 18.7 per cent. The most backward was the *Ranger*, 1.8 per cent.

It is not likely that the British cruisers will carry as many as twelve 16-inch guns, because the extra weight added to the heavy armor plate would compel a reduction of speed to less than 30 knots. Assuming 10 to be the number of guns decided on, these new cruisers would be inferior as fleet units to the American battleships of the *Indiana* class, which will have a displacement of 43,200 tons and be armed with main batteries of twelve 16-inch guns. This American class will probably be seven knots slower than the British battle-cruisers, but with extraordinary armor protection the Americans should be able to withstand tremendous shell and torpedo attack. It should be noted, however, that the latest British shell for 16-inch guns has greater penetrating power than the American shell, according to reports of a test made upon the hull of the former German dreadnought *Baden*.

The decision of the British Government to expand its fleet, somewhat stronger at the present time than the American fleet, signifies a purpose to keep abreast of the United States in sea power if limitation of armaments is not agreed upon at the Washington conference. In the debate in the House of Commons upon navy estimates in March, every speaker who urged the Government not to let the British Navy sink to second place was loudly cheered. The most popular sailor in the empire is Earl Beatty, not only because he fought in the Nelson style at Jutland, but because he stands for a navy as strong as any other. It has been said that "the British people will never consent to be ousted from the element which instinct, no less than history, teaches them to be the true source of their national safety and prosperity."

As sure as the sun sets on a disarmament conference that has not bound the nations to cease competition in the building of warships, Great Britain, the United States and Japan will go on spending the major part of the money they raise by taxation in preparations for war. The end of the rivalry would be financial collapse for more than one of them, perhaps for all three. But it is an expectation not unduly optimistic that the conference will be able to agree upon Pacific policies. In that case the problem of limiting armaments could be solved without difficulty.—*N. Y. Times*, 24 August, 1921.

JAPAN

JAPAN SCRAPPING OLD SHIPS.—Pursuant to the decision taken at the Japanese Navy Department conference in May, Admiral Kato, the Minister of Marine, has now drawn up a program of economy which, it is hoped, will result in a considerable saving of expenditure without interfering with the carrying out of the "eight-eight" program. Within the next two years it is proposed to scrap four battleships, aggregating some 57,000 tons, two first and three second-class cruisers totalling 30,200 tons, and a number of coast-defense ships, destroyers, torpedo-boats, and auxiliaries. The old vessels marked down for the scrap-heap are the battleships *Shikishima*, the *Asahi*, the *Hizen*, and the *Mikasa;* and the cruisers *Asama*, *Tokiwa*, *Suma*, *Akashi*, and *Chitose*. Furthermore, the *Ikoma*, the *Ibuki*, and the *Kurama*, officially designated "battle-cruisers," are to be disrated to first-class cruisers; and the old armored cruisers *Yakumo*, *Adzuma*, *Idzumo*, and *Iwate*, together with the obsolete light cruisers *Niitaka* and *Tsushima*, will be placed in the category of "coast defence ships." The proposed measures of economy are much less drastic than had been anticipated, and even when they have been carried into effect the Japanese Navy will contain many vessels so limited in fighting value that their upkeep would not be considered worth while in the British service.

The mystery of the *Nagato's* wonderful foremast has now been solved. It is a heptapod, the trunk being supported by six powerful struts, carrying a series of searchlights, range-finder platforms, and director towers. The trunk of the mast is of such generous diameter that it contains an electrically-operated lift, running from the upper deck to the masthead, where the main armament director tower is situated. The mast was designed after many experiments had been made to determine the best form of structure for securing rigidity and reducing vibration to the minimum. It is said, and certainly looks, to be indestructible by shellfire, but the weight involved must be enormous.

Unofficial details of the new aircraft-carrier *Hosho*, building under the 1919 estimates, show her to be a vessel of some 9000 tons, with a speed of 21 knots. Her machinery will consist of geared turbines and oil-fired boilers, the smoke being expelled through horizontal ducts as in H. M. S. *Argus*, leaving the flying deck clear of obstructions. She is to have the largest possible accommodation for aeroplanes, accessories, etc., and will be fitted with the latest devices for facilitating the landing and recovery of aircraft. An armament of four 4.7-inch Q. F. and two A. A. guns will be mounted.

It is understood that practically all the armor-plate, amounting to about 7000 tons, which the Japanese Navy Department ordered from a Sheffield firm two years ago, has now been delivered. It is special curved armor for conning-tower and barbette protection. Hopes are cherished at Sheffield that further orders will be forthcoming from the same quarter, but in the meantime Japan is doing what she can to enlarge her own facilities for the manufacture of this material, and is buying machinery for the purpose. A 16,000-ton armor-plate bending press is said to have been acquired from a British firm for erection in the shops at Kure dockyard. As regards raw material, it is interesting to learn that Japan is making large purchases of the Swedish magnetic ore which found its way to the Krupp works at Essen is such quantities during the war. But with the big program of armored ship construction well under way, Japan will find it difficult to meet the heavy demand for armor from her own resources, especially as

the Muroran works—which have hitherto cooperated with the state factory at Kure in supplying this material—are finding it difficult to fulfill Admiralty orders owing to the narrow margin of profit thereon. The directors of the Muroran firm have been in negotiation with the Navy Department on this subject for many months past, but apparently without reaching an agreement. There is consequently some likelihood of British manufacturers coming in for a further share of business in connection with the "eight-eight" program. The Japanese papers state that two light cruisers of this program were to have been ordered in Great Britain last spring, but that the decision was revoked when it was found that the British firms demanded £20 per ton in excess of the highest Japanese tender for the work.—*The Naval and Military Record*, 10 August, 1921.

JAPANESE SUBMARINES.—Comment has been caused in naval engineering circles by the report that the Japanese Government has placed an order with Sulzer Bros. for Diesel engines to the value of £1,250,000, which are to be installed in the new super-submarines. Only bare details are available, but they indicate that the engines are to be of 4000 horsepower, and that it is intended to equip each of the new submarines with engines aggregating from 16,000 to 20,000 horsepower. A similar order, but for engines of a lower horsepower, has been placed with the same firm by the United States Government.—*The Engineer*, 12 August, 1921.

METRIC SYSTEM IN JAPAN.—The Board of Trade state they have now obtained a translation of the recent Japanese Law (number 71 of 1921), the object of which is the ultimate substitution of the metric system of weights and measures for the present Japanese system.

Among the provisions of the new law are:

Article 1.—The unit of measurement shall be the meter and the unit of weight the kilogram [these are substituted for the "shaku" and the "kwan"].

Article 2.—The meter shall be determined by the standard meter delivered to the Imperial Government in accordance with the Metric Treaty, and the Kilogram by the standard kilogram delivered to the Imperial Government according to the Metric Treaty.

Article 5, Clause 2.—This provides that weights and measures or standards of measurement not in accordance with the new law, or with Imperial Ordinances based on that law, may not be used in business transactions or for purposes of certification unless otherwise determined by Imperial Ordinances.

Articles 6 to 14.—In the old law these imposed certain restrictions on the manufacture and sale of weighing and measuring appliances, provided for the official inspection of such appliances, and set up regulations regarding the sale of goods marked with their net weight. In the new law these are all retained.

Penalties.—Among the penalty sections of the law, it is provided by Article 15 that persons infringing Clause 2 of Article 5 above are liable to a fine not exceeding 100 yen or a police fine.

Supplementary Articles.—The date of enforcement of this law shall be determined by Imperial Ordinance.

The weights and measures in common use hitherto may continue in use for such period as will be determined by Imperial Ordinance.

A copy of the law may be inspected at the Department of Overseas Trade (Development and Intelligence), 35, Old Queen-street, London, S. W. 1.—*Engineering*, 29 July, 1921.

UNITED STATES

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, AS REPORTED AUGUST 31, 1921

Type, number and name	Contractor	Per cent of completion			
		Sept. 1, 1921		Aug. 1, 1921	
		Total	On ship	Total	On ship
Battleships (BB)					
44 California	Mare Island Navy Yard..Com	m. 8-	10-21	99.	99.
45 Colorado	New York S. B. Cpn.	78.4	76.8	77.1	75.2
47 Washington	New York S. B. Cpn.	69.3	63.	68.8	62.4
48 West Virginia	Newport News S. B. & D. D. Co.	61.	53.4	59.3	51.3
49 South Dakota	New York Navy Yard	34.1	26.5	32.8	26.5
50 Indiana	New York Navy Yard	31.2	24.	31.2	24.
51 Montana	Mare Island Navy Yard	27.3	19.	26.6	18.8
52 North Carolina	Norfolk Navy Yard	36.5	27.1	36.1	27.1
53 Iowa	Newport News S. B. & D. D. Co.	29.	24.8	28.3	24.7
54 Massachusetts	Beth. S. B. Cpn. (Fore River)	10.4	3.9	10.4	3.9
Battle Cruisers (CC)					
1 Lexington	Beth. S. B. Cpn. (Fore River)	24.2	15.	23.1	13.8
2 Constellation	Newport News S. B. & D. D. Co.	13.3	11.1	12.5	10.3
3 Saratoga	New York S. B. Cpn.	27.4	18.7	25.6	16.9
4 Ranger	Newport News S. B. & D. D. Co.	2.5	1.	2.2	.9
5 Constitution	Philadelphia Navy Yard	10.7	6.	10.4	5.9
6 United States	Philadelphia Navy Yard	10.4	5.7	10.2	5.7
Scout Cruisers (Light Cruisers CL)					
4 Omaha	Todd D. D. & Const. Cpn.	94.6	87.2	93.9	85.7
5 Milwaukee	Todd D. D. & Const. Cpn.	92.4	84.	91.3	83.
6 Cincinnati	Todd D. D. & Const. Cpn.	87.1	79.5	86.2	78.8
7 Raleigh	Beth. S. B. Cpn. (Fore River)	63.7	45.6	63.2	45.6
8 Detroit	Beth. S. B. Cpn. (Fore River)	66.3	48.2	63.7	46.1
9 Richmond	Wm. Cramp & Sons Co.	70.	59.	69.	51.
10 Concord	Wm. Cramp & Sons Co.	66.	49.	65.	45.
11 Trenton	Wm. Cramp & Sons Co.	50.	34.	50.	32.
12 Marblehead	Wm. Cramp & Sons Co.	46.	30.	46.	28.
13 Memphis	Wm. Cramp & Sons Co.	40.	25.	40.	25.
Auxiliaries					
Fuel Ship No. 18, Pecos	Boston Navy Yard (Oiler AO 6)	Com 8-	m. 25 21	99.	99.
Repair Ship No. 1, Medusa (AR 1)	Puget Sound Navy Yard	68.	51.2	66.	50.3
Dest. Tender No. 3, Dobbin (AD 3)	Philadelphia Navy Yard	66.3	66.	66.3	66.
Dest. Tender No. 3, Whitney (AD 4)	Boston Navy Yard	32.8	28.1	30.6	24.5
Sub. Tender No. 3, Holland (AS 3)	Puget Sound Navy Yard	21.6	5.5	21.5	5.5
Aircraft Tender, Wright (AZ 1)	Tietjen & Lang	90.	....	87.	....
Patrol Vessels					
Gunboat No. 22, Tulsa (PG 22)	Charleston Navy Yard	70.6	53.4	70.3	52.1

In addition to the above there are under construction 4 destroyers, 4 fleet submarines, and 37 submarines.

Authorized but not under construction or contract 12 destroyers, 7 submarines and one transport.

"CALIFORNIA" IN COMMISSION.—The battleship *California* was placed in commission at the Mare Island Navy Yard yesterday in the presence of a large gathering of naval officials and visitors.

The keel of the ship, which is the first dreadnought to be turned out by this navy yard, was laid October 25, 1916. All work on the *California* was suspended during the war to give precedence to the building of destroyers. She was launched November 20, 1919. The *California* carries 1400 enlisted men, all California men.—*The N. Y. Times,* 12 August, 1921.

SUBMARINE "S-51" LAUNCHED.—The *S-51,* last of the submarines now under contract for the United States Navy to be built here, was launched from the ways of the Lake Torpedo Boat Company to-day.—*The N. Y. Times,* 21 August, 1921.

WORK ON BATTLESHIPS CUT.—Curtailment of naval building due to decreased appropriations will materially slow up work on new battleships and battle-cruisers, it was said to-day at the Navy Department. There is $53,000,000 available for the work, against $115,000,000 requested, and it has been apportioned about evenly between purchase of materials and building charges after conference with builders and materials contractors.

A partial suspension of work at plants fabricating material for the ships already had taken place, it was said. Officials did not estimate when the vessels could be completed at the present rate.—*The N. Y. Times,* 17 August, 1921.

NAVAL PROGRAMS.—The American people have about $40,000,000 invested in the new battleship *Washington,* just launched at Camden. This investment was made to protect the lives and property of the people who furnish the money to pay battleship bills. It could not be spent to better purpose if other nations continue to build big battleships. But it could be better spent in the ways of peace under an international agreement for disarmament.

Great Britain, Japan and the United States have the greatest naval programs planned at the present. The British navy's fighting ships are counted at 1,588,442 tons, those of the United States at 779,173 tons and of Japan at 340,596 tons. The United States has new ships planned that will total 842,109 tons, Japan 328,460 tons and Great Britain 76,890 tons. If these programs are carried out, Great Britain will have 1,665,332 tons, the United States 1,621,282 tons and Japan 669,056 tons. Thus the strength of the American Navy will be almost as great as that of the British Navy, ship for ship and ton for ton.

According to current history, France is maintaining 800,000 soldiers under arms, Japan 600,000, Great Britain 300,000, Italy 300,000 and the United States 150,000. Thus it will be seen that this country has put the army on a peace-time footing, but its naval program is ambitious. There is considerable doubt about the disarmament conference being able to curtail the programs and the effect of such an agreement as the diplomats reach may not be felt by the people for some time, but if it means less spent for war preparation something will have been accomplished.—*The Indianapolis News.*

SECRECY SHROUDS FLEET PRACTICE.—Beginning September 6, the American fleet in the Pacific will begin its fall maneuvers under a complete veil of secrecy. Never since the war has so much obscurity been thrown about fleet movements as will govern this practice routine. No reason is assigned for the new order of fleet practice, although the reason for it is assumed to lie in the necessity of trying out new units of the fleet under novel conditions.

The fighting strength of the navy is acknowledgedly now in the Pacific. The fleet has the latest equipment in aircraft, in radio systems, range finders, and will specifically seek to find a proper balance between the

different units, such as the battleship, the submarine of wide cruising area, the aircraft subsidiaries and other features of a thoroughly equipped fleet.

The bombing experiments which were tried on the Atlantic coast this summer will be tried out under other conditions in the practice maneuvers in the Pacific. It is earnestly desired to know just what relations the aircraft and the battleships are to bear to each other in the future.

The maneuvers will include various strategic enterprises carried out under the stimulation of war conditions.—*The Washington Post*, 6 September, 1921.

LIMITATION IS NOT DISARMAMENT.—President Harding in his speech at the War College said that the time may never come, or the time will never come, when the United States can do without an army. That was a natural enough statement to make on such an occasion, but the significance went beyond the occasion, and no doubt the President intended that it should.

The Washington conference of nations interested in the limitation of armament and the adjustment of Pacific controversies is being misconceived widely in the United States as to purpose. Part of this may be deliberate and political. Some may be sentimental and pacifist, and in it all there is a large element of carelessness. To speak of the "disarmament conference" is to use a term which does not fit the purpose of the conference at all.

It may fit the purpose of politics, Wilsonian Democrats and the league of nations advocates may endeavor to create a false impression in advance by using this term. The purpose is not disarmament. Consequently the result obtained, even if it is the best hoped for, will not be disarmament. Politics by misrepresenting the purpose in advance may afterward assert that the result was failure. President Harding probably is aware that the purpose is being misrepresented.

It is not expected that the United States, Great Britain or Japan will put effective battleships out of commission. It is not expected that as the result of the conference there will be a reduction in armies. Great Britain and the United States have their armies down to the bone already, and Japan, France, Italy, etc., will continue to be guided by what they regard their peculiar national needs.

If armies and navies were reduced, the process might be called disarmament, even if all arms were not thrown away, but the purpose of the Washington conference is not that. It is broadly to reach an agreement which will stop dangerous, competitive military preparations.

Particularly it is to reach an agreement which will stop the rivalry in the building of battleships.—*The Chicago Tribune.*

AIR MENACE TO THE NAVY.—In all the discussions in connection with the recent bombing tests against the German ships, attention has been given almost exclusively to arguments as to whether or not the modern battleship is doomed in a contest with air forces.

It is natural, perhaps, that this point should monopolize thought. Nevertheless it is important to note that the battleship is menaced not only by direct attack from air forces, but that its existence is, perhaps, threatened more seriously by the probability that its protecting screen of light cruisers and destroyers, as well as its supply and fuel ships, may be bombed, gassed, torpedoed or mined off the sea! In such a case what can the battle fleet do? Even if the air forces of the enemy leave it untouched, is it not powerless when it loses control of the air and thereby finds itself robbed of all scouts, all protection against submarine attack, all supplies and fuel? Under such conditions will somebody answer the important question—what can a battle fleet do and where can it go?

One of the most important auxiliary forces of the battle fleet is the destroyer flotilla, whose function it is to protect the battleship against submarine attack, to threaten the enemy with torpedoes, to embarrass him with smoke screens, and to do scouting duty in company with cruisers of all kinds. These are important defensive and offensive functions. Has the advent of air forces imperiled the existence of the destroyer? Can it be counted on to accomplish in the future the mission that has been assigned to it in the past? If so, it must prove its ability to defy and fight off attack from the air. Can it do this? Is it reasonable to expect such a thing?

Consider for a moment the weakness of the destroyer against air attack. Its upper deck is thin, and so also is its side and bottom plating. A 100-pound bomb will penetrate its deck, and the same bomb exploding in the water near by will unquestionably open its seams and send it to the bottom or put it out of action in a few minutes. This was proved by the recent experiments.

The upper deck of a destroyer is encumbered with many depth charges and torpedoes containing high explosives that may be detonated by an explosion near by. Nearly half the length of the ship is given to engines and boilers quite unprotected by armor, and very vulnerable to bombing. Even the magazine is at the mercy of attack from above.

For use against air attack the destroyer has two anti-aircraft guns. A casual inspection will show that these guns have a very limited field of fire—smokestacks, masts, superstructures and bridges interfere with them. The destroyer rolls and pitches violently in a seaway. Under such conditions the gunners cannot shoot with accuracy. The airmen do not fear these guns. In the recent gun attack by destroyers on a German target the commanding officer signaled that the motion of his ship in a smooth sea at a speed of 30 knots made it impossible for him to hit the target. If this motion interfered with the accuracy of his 5-inch guns it would still more embarrass his anti-aircraft guns. And yet it is admitted that high speed is necessary to escape air attack. It is not too much to say, therefore, that the structural weakness of the destroyer and its inability to successfully fight the airplane have sounded its doom. It is absurd to say that the bomber cannot hit a fast zig-zagging ship. The air man will come down so close that he cannot miss. He may not sink the destroyer, but he will at least put it out of action. Air forces will dominate in battle with destroyers.

If we admit the vulnerability of the destroyer to air attack, what manner of ship must replace it in the duty of protecting the battleship and in the use of torpedoes, small guns and depth charges, or mines—for these are the weapons that are carried by the destroyer?

It would appear that the destroyer must be converted into a submarine—in other words, it must dive to escape the air man. The submarine uses the identical weapons carried by the destroyer—small guns, mines and torpedoes. To be sure a German submarine was recently destroyed by bombs. But it must be remembered that she was lying helpless on the surface. No submarine or submersible will remain on the surface in the face of an air attack. A submarine can dive in less than a minute, and in such a case the air man is checkmated—he cannot hit an invisible target.

The submersible which replaces the destroyer must have high speed on the surface. In this there will be a sacrifice—a compromise. It cannot have as great speed as the present destroyer, but it may be fast enough to accompany the battle fleet. It must surrender some speed to gain submersibility and escape destruction.

The extreme vulnerability of destroyers and light cruisers to air attack presents an unfortunate and perplexing situation, especially for the United States Navy. We have 300 modern destroyers. They were built for use against German submarines, but, unhappily, the Daniels administration so

delayed their building that only eight of the new ones were used in the World War. They cost about $600,000,000.

Previous to the recent bombing tests, the writer considered these destroyers a powerful asset. But in the light of recent happenings their usefulness in modern war is questionable. They will be of little value if our enemy commands the air. Under those conditions destroyers cannot live.

This brings us up against a stone wall of truth. A surface fleet in the year 1921 must control the air. Battleships, cruisers, destroyers, colliers, tankers and supply ships cannot long exist upon the sea against an enemy that can cruise at will in the air above and subject surface ships to a continuous rain of bombs, torpedoes, mines and poison gas. The unarmored ships will be destroyed with ease, leaving the dreadnought at the mercy of submarine attack, as well as helpless against air attack.

Such is the unhappy condition of the United States Navy to-day. Conservatism and shortsightedness at the Navy Department and in Congress have deprived our battle fleet of the modern weapons—aircraft and submarines—that are most essential in naval warfare. We have spent $1,500,000,000 on battleships and surface vessels that are in themselves helpless in modern war.—*The N. Y. Times*, 28 August, 1921.

GEORGETOWN WILL TRAIN SEA EXPERTS.—For the first time on record the profession of shipping is to be included in the curriculum of an American university. Georgetown is introducing the innovation with the college year just about to open. The course will be given at the "school of foreign service," which is the only one in the United States as a branch of a university and giving full-fledged degrees. Graduates, presumably, will be enabled to aspire to the degree of "doctor of shipping."

The new course will be under the direction of Dr. Roy S. MacElwee, dean of the school of economics, who was formerly director of the bureau of foreign commerce at the Department of Commerce. It will include the following basic subjects:

Subjects in the Course.—Ocean transportation (history and organization), ports and terminal facilities (worldwide in scope), steamship office management, wharf management and warehousing, steamship classification and elements of construction, steamship operation, marine insurance, export packing and ship stowage, shipping legislation, admiralty law, railroad law, railroad traffic and rates.

The avowed object of the Georgetown course in shipping is to train a generation of young Americans scientifically equipped to tackle ocean-carrying problems, just as colleges and universities now train lawyers, doctors and newspaper men. Experienced and practical shipping men will act as instructors, or as occasional lecturers.

In Shipping from Boyhood.—Among them is W. L. Bull, assistant to the Vice-President of the Emergency Fleet Corporation, who began his career as a boy with the Mallory Line and was an official of that organization until the war, having passed through every stage of the shipping industry in managerial capacities. Another instructor will be A. H. Haag, who also has had a varied experience, having been associated with the Newport News Shipbuilding and Dry Dock Company and later with the United States Shipping Board as chief constructor.

Discussing the new shipping course, Dr. MacElwee said:

A West Point in Shipping.—"It is often said the United States cannot hope to compete successfully with British mercantile marine because of Britishers' centuries of experience and tradition as transoceanic carriers. We cannot, of course, begin where the British began. We must do our best to operate as soon as possible on terms of equality. That, it seems to Georgetown University, can most effectively be achieved by systematic instruction in the fundamentals of shipping in all its varied branches. We shall teach, in other words, what the British have done and how they did it.

"It is ignorance of basic principles that is responsible, to a large degree, for the inability of Americans to attain that eminence in the world shipping trade which it is easily within our power to reach. Capital alone will not suffice. If America had had a West Point or an Annapolis of shipping in operation for years before the war, we would have been ready to meet the shipping emergencies of the situation with far greater skill than we did and at incalculable money-saving to the country. It is in the hope of educating and breeding a race of American shipping experts that Georgetown's new venture has been instituted."—*The Washington Post*, 11 September, 1921.

DRASTIC AMERICANIZING POLICY TO BE INAUGURATED BY SHIPPING BOARD.—Under the new policy of the Shipping Board, Americanizing is to be the keynote in all departments of service. Officers and crews are to be all American. Foreigners are to be dropped from office staffs in foreign countries as well as in the United States. At present the American merchant marine includes many British officers and men, especially in the engine rooms. In the London offices of the board there are British employees, and in ports all over the world aliens are utilized. The intention is to substitute Americans.

Six Thousand Employees.—The employees of the Shipping Board and the Emergency Fleet Corporation number more than six thousand at present, and those who are looking toward economical as well as efficient operation of the board and the corporation appear to be convinced that half that number can do the work. The reduction will be made gradually, after thorough investigation and study. One of the first blows will probably be directed at the London office of the Shipping Board, where a large majority of the employees are British. The new board will try to get along with fewer employees and have them all Americans. If the board has to raise salaries in order to establish an all-American force in London, this will have to be done. The same plan will be adopted elsewhere.

The most important changes contemplated, however, are those that have to do with the crews on vessels in which the Shipping Board has complete or part ownership. Some of these ships are being operated for the board and others are being paid for in installments. After the Board gets reports on the crews of all these vessels, it will begin its drive to Americanize the mechant marine from top to bottom, from captain to deck hand.

Various obstacles have thus far prevented the establishment of 100 per cent American crews. During and after the war period it was necessary to use a larger percentage of foreign seamen. Foreigners were also authorized to officer American ships, receiving what is known as "red ink licenses." Some of these are still in effect, but in the near future they will be cancelled. The majority of the holders are British, particularly the engineers. The percentage of American engineers is extremely small. The board, however, is determined to put American engineers in charge as soon as possible.

Many of the vessels operated by private companies depend upon foreign port officers in various parts of the world. While this is often necessary, it believed that the board will be able to put Americans in a number of ports where the interests of American vessels are now in the hands of foreigners. American shipping men are confident that by doing so the board will be adding materially to the business of American ships. The board fully anticipates that complaints will be received from various operating companies over the demand that certain officers in foreign ports be replaced by Americans, but the board will insist upon the desired changes.

Vigorous opposition to the Shipping Board's new policy of Americanizing ships is expected to be made by the International Seamen's Union. As its name suggests, this organization is international in character and officials of the board who have been investigating it assert that not more than 50 per cent of its membership is American. For some time past the union

has been manning ships from its own lists and supplying a majority of foreigners. The system will be fought by the Shipping Board, which takes the ground that under all conditions American seamen are entitled to take precedence over foreigners in getting berths on American ships.

The Shipping Board, moreover, is eager to draw young men to the American merchant marine, believing that there are plenty who are ready and willing to go to sea under proper conditions. With the present large pay of seamen on American ships, and officers and crew entirely American, the merchant marine would eventually be manned by a force superior to that of any other country, while a much higher grade of efficiency would be attained.

The Americanizing policy of the Shipping Board has been strongly endorsed by the American Steamship Owners' Association, which has taken an active interest in the newly organized American Seamen's Association, membership in which is limited to Americans. This association is expected to offset the effect of the marine unions controlled by the foreign element, which have exerted every effort to keep Americans from obtaining employment on American ships.

Doubt Expressed.—In spite of the Shipping Board's pronouncement and the backing it has received from the American Steamship Owners' Association, the majority of operators are outspoken in expressing the opinion that the idea of 100 per cent American crews for American steamships is impractical "bunk." While Americanizing is admitted to be an excellent thing in its way, it would be just as well, they say, to let every alien stay in his job until an American, well-equipped, can be put in his place. Otherwise Americanization will result in mere flag waving instead of sound business, and the merchant marine will function even worse under the new régime than it did before.

In discussing the subject with a *Nautical Gazette* representative this week, an American skipper who had commanded both sailing vessels and steamers said that the idea of the board was absurd. "These are not the days of clipper ships," he remarked. "Young Americans of fair education can get much better wages and opportunities ashore. Why should they go to sea? And what sort of sailors are there on steamers nowadays? Cleaning brasswork, scrubbing decks and doing all sorts of other chores. That doesn't sound very attractive. Young men will enlist in the United States Navy because life on the warships has a great deal of interest, and there is always a chance for promotion; but you will find very few young Americans worth their salt who are pining to get jobs on freight steamers at $55 a month."

A similar opinion was expressed by the vice-president of one of the largest American shipping companies. While he conceded that the captains, deck officers, engineers, and assistant engineers should be American, and also the machinists and other mechanics in the engine room, it was unimportant, he said, whether the rest of the ship's company were American or of some other nationality. "Can any man tell me," he observed, "why any young American should be eager to accept the job of an unskilled or manual laborer at sea any more than on shore? You can't get Americans any longer to dig ditches or carry hods; you depend upon certain grades of foreigners for such tasks. In the fire room you can get much better results from Lascars, Chinese or Greeks. Americans don't take to the water now, and since the end of the clipper days they have paid less heed to the call of the ocean."

E. A. Quarles, assistant to the president of the U. S. Mail Steamship Co., said that he doubted whether 100 per cent Americanization in the complement of American ships would ever be successful, however desirable such a transformation might be. Neither Great Britain nor any other maritime country had ever been able to man ships entirely with its own nationals.—*The Nautical Gazette*, 13 August, 1921.

GERMANS ENTER U. S. AS SEAMEN, SAYS LASKER.—Numbers of Germans are shipping at German ports on American-bound vessels as seamen at wages of one cent a month, Chairman Lasker, of the Shipping Board, has advised Secretary Davis. The belief was expressed by Secretary Davis that the Germans are permitted to land in this country as seamen, and then flee to the interior. He said he expected to ask that a bill be introduced in Congress requiring the registration upon arrival of all foreign seamen. There are probably 40,000 Chinese in this country without legal right to be here, he added, as a result of their taking advantage of the Seaman's Act.—*The Nautical Gazette*, 13 August, 1921.

AERONAUTICS

DEVELOPING AIR DEFENCE.—By the 15th of this month it is expected that the old battleship *Alabama* will be ready at Philadelphia navy yard to be delivered over for airplane bombing tests in Chesapeake Bay. These tests will be novel in many respects, and should elucidate several points about which there has been some dispute. It is not expected, however, that there will be any developments which will change the fundamental facts brought out through the recent tests which ended in the sinking of the former German battleship *Ostfriesland* and other vessels. In those tests the efficacy of airplane bombs in destroying surface vessels, even without striking them, was fully demonstrated. The terrific shock administered to steel plates by the explosion of bombs in the water near the vessels was sufficient to open the seams and send the ships to the bottom. Probably if there had been human beings aboard they would have been killed by the concussions. The forthcoming tests will include experiments in night bombing in the light of 100,000 candlepower flares dropped in parachutes from the bombing planes. These lights will illuminate the target while the parachute cover will keep the plane in darkness. Experiments will be made with gas bombs, to ascertain the extent to which various kinds of gas permeate a vessel and cover the sea surface. The bombs containing T. N. T. will be of various sizes, some of them holding 4000 pounds of the explosive.

The indefatigable efforts of the army and navy aviation officials and personnel are bearing good fruit and are worthy of all commendation. Through these efforts and through the daily and hourly exertions of flyers the development of aviation in this country is proceeding, in spite of the reluctance of Congress to acknowledge the necessity of adequate provision for air defense. This defense must be provided, if not in peace then under the stern necessity of war. Battleships costing $40,000,000 each must not be subjected to bombardment from above, and the only method of preventing such attack is to provide an air force that will beat off any force coming against it. The air above a sea fleet must be possessed by the side possessing the fleet. Once the air is lost, the havoc wrought by aerial bombs under practice tests may be wrought in actual warfare.

The United States will surely develop an air force for naval as well as for military purposes. The ground work for such development has been laid. But the development is exasperatingly slow to those experts who have grasped the full significance of air strategy as a concomitant of naval and military strategy. In the next war, they hold, it will be as big a mistake to fail to hold control of the air as it would be to fail to control strategic points on land or naval bases. The mobility of air forces is such as to render military and naval operations doubtful unless the danger of a counterstroke from the air is eliminated. This can be accomplished by holding control of the air above the region of operations. In short, a struggle for mastery of the air is probable in every case hereafter before the struggle on land or sea. This evolution of warfare was repeatedly forecast on the battle fronts during the late war, and naval aviation foreshadows the same situation in sea operations, at least those offshore. As

airplane carriers are under construction by several navies, the time is at hand when air operations will be possible far out at sea.

The bombing of the *Alabama* should bring out much information of value in the construction of battleships to resist the shock of bombs. But it would be hopeless to attempt to build ships capable of defying air bombs. They cannot be constructed in such manner as to survive the shock. Every human being on board a vessel struck by a 4000-pound bomb of T. N. T. would be killed or shocked into insensibility, leaving the vessel helpless, even if it were not sunk. Moreover, gas bombs of deadly nature would rain down upon the ship, making sure of the disablement of all the personnel. Experience has shown that anti-aircraft guns are practically worthless as a defence against air attack. The defence must be airship against airship. Similarly, coast fortifications must be protected by air defences which can beat off the air enemy. As for armies, there is no pretense that they can exist without air defence.

Thus, from any angle considered, the problem yields only to one solution—the creation of air defences strong enough to cope with any possible air offensive. This conclusion means the development of air forces to a point far excelling anything now in existence, both in skill, numbers and equipment.

No doubt the general question of air warfare will be considered by the Washington conference. One thing is certain, however; there can be no just complaint by any nation against the air armament of the United States, or against its program in that direction. The immense territory and long coast lines of the United States are defenceless from the air, and will be for many years at the present rate of progress. The nation is to be criticized, not for arming itself for air operations, but for leaving itself defenceless and thereby endangering its costly naval vessels, its forts, the Panama Canal, and its ports and cities.—*The Washington Post*, 9 September, 1921.

REPORT OF JOINT ARMY AND NAVY BOARD ON BOMBING AND ORDNANCE TESTS.—1. The Secretary of War and the Secretary of the Navy have approved the following report of the Joint Board on result of aviation and ordnance tests held during June and July, 1921:

Nature of Experiments and the Results.—2. Certain ex-German war vessels having been turned over to the United States Government in accordance with the decision of the Supreme Council as to their allocation, the Navy Department decided to comply with the provision requiring their destruction by conducting a series of experiments in which these vessels were to be sunk by gunfire or by bombs dropped from aircraft. In order that both branches of the national defence might gain the maximum benefit the Secretary of the Navy invited the army to participate in these experiments.

3. In addition to the experiments with the ex-German vessels as targets, one was conducted with the ex-*Iowa* steaming under radio control as a hypothetical enemy. Search was conducted by aircraft and attacks made using dummy bombs from 4000 feet altitude. This experiment was conducted with a view to obtaining information as to the effectiveness of aircraft in search operations, the ability of aircraft to concentrate for effective attack on a vessel at sea, and the percentage of hits which could be made by dropping bombs from this altitude under the most favorable conditions against a slow moving target capable of changing course at will to decrease the accuracy of bombing.

4. The aviation experiments were successfully conducted under the direction of the commander-in-chief, Atlantic fleet, by the air force of the Atlantic fleet and a provisional air brigade of the army. The gunfire experiments were conducted by destroyers and battleships of the Atlantic fleet.

5. The experiments extended over the period from June 21st to July 21st, and resulted in the sinking of the ex-German vessels as indicated below:

Type	How Sunk	Date
Submarine *U-117*	Bombs	21 June
Submarine *U-140*	Gunfire	22 June
Submarine *UB-48*	Gunfire	22 June
Destroyer *G-102*	Bombs	13 July
Destroyer *S-132*	Gunfire	15 July
Destroyer *V-43*	Gunfire	15 July
Light Cruiser *Frankfurt*	Bombs	18 July
Battleship *Ostfriesland*	Bombs	21 July

6. The schedule of experiments was so arranged as to obtain the greatest amount of information for the practical development of aviation and ordnance including weapons, their appurtenances, and projectiles. Boards of observers were appointed by the War and Navy departments.

7. The experiments definitely determined in each case that the projectiles used were superior to the defensive features of construction of the vessel attacked. It has long been recognized that the gun carried by any type of war vessel is superior at moderate ranges to the armor or protective construction of vessels of like type. In a large measure, therefore, the greatest interest in these experiments lay in the bombing of naval vessels by aircraft. The main features of this report, therefore, relate to the effectiveness of aircraft in offensive action against various types of naval vessels.

8. The Joint Board has carefully studied the reports of the boards of observers and as a result of such study, actual observation of the experiments by one or more members of the Joint Board, and general knowledge of the principles of war and methods of conducting war, has arrived at the following general conclusions:

General Conclusions.—9. Within their radius of action, which, relative to that of naval vessels, is extremely short the effectiveness of heavier-than-air-craft carrying large capacity high explosive bombs, depends upon:

(a) Ability to locate the naval vessel,
(b) Ability to hit the target vessel with the projectile carried,
(c) Ability of the projectile to damage or destroy the vessel.

Consideration of Ability to Locate the Naval Vessel.—10. Aircraft of any of the three general classes: lighter-than-air ships, flying boats and land planes, either in combination or singly, have pronounced ability to search sea areas within their radii of action and to locate naval vessels operating in such areas. The high speed of aircraft and the range of visibility obtained by altitude are factors which make these craft especially valuable in the service of information.

11. Heavier-than-air craft may obtain the maximum radius of action for use in the service of information only by carrying additional fuel in place of heavy bombs. When armed with heavy bombs the radius of action of heavier-than-air types is inadequate for extensive search operations. Therefore, to conduct an effective attack on naval vessels it will usually be necessary to have certain aircraft for searching and others for conducting the attack with bombs.

12. Darkness, fog, falling or squally weather, will greatly reduce the effectiveness of aircraft in search operations. Most of these conditions likewise adversely affect surface vessels conducting such operations but not to the same extent.

13. The present dependability of the personnel and material of the army and navy aircraft appears to be such as to ensure that search operations, under suitable conditions, can be conducted without an undue percentage of loss. The further development of aircraft will undoubtedly increase both dependability and radius of action.

Ability to Hit the Target Vessel With the Projectile Carried.—14. The number of dummy bombs which actually hit the target during the experiment with the ex-*Iowa* was a very small percentage of those dropped. Other experiments, however, showed that it is not necessary to make direct hits on naval vessels to put them out of action or to sink them, provided the bombs drop sufficiently close to the vessel and the explosive charge is sufficiently large to produce a mine effect of such proportions as to destroy the water-tight integrity of the vessel beyond the control of its personnel and pumps. The effective target for the bomb being, therefore, greater than the deck area of the target vessel, the percentage of effective bombs would be greater than the percentage of actual hits.

15. Inasmuch as these experiments were not conducted under battle conditions it is difficult to draw conclusions as to the probability of hitting a target with bombs from aircraft while in action. Under the favorable conditions existing during the experiments—namely, stationary, or practically stationary, target, immunity from enemy interference and excellent visibility and flying conditions, the percentage of hits was greatly in excess of that to be expected under battle conditions.

16. The probability of hitting will be reduced in the case of a target moving at high speed on varying courses; further reduced if the target vessel is protected by effective anti-aircraft armament; and practically negligible if the target is protected by effective pursuit planes. On the other hand the probability of hitting will be increased by more efficient sighting and bomb-dropping control apparatus, by further training and further development of aerial tactics.

17. In the present state of anti-aircraft defence it is believed that, if an air force can obtain the mastery of the air, an effective percentage of hits can be obtained against surface vessels coming within the radius of action of bombing planes without an undue percentage of loss of aircraft. Anti-aircraft armament is in an early stage of development. The history of war indicates that means of defence develops rapidly to meet the development of offensive weapons. The effectiveness of the bomb carried by aircraft emphasizes the necessity for the rapid development of anti-aircraft armament and for the provision of pursuit planes as a part of the fleet.

Ability of Aircraft to Damage Naval Vessels.—18. Aircraft carrying high-capacity, high-explosive bombs of sufficient size have adequate offensive power to sink or seriously damage any naval vessel at present constructed, provided such projectiles can be placed in the water close alongside the vessel. Furthermore, it will be difficult, if not impossible, to build any type of vessel of sufficient strength to withstand the destructive force that can be obtained with the largest bombs that aeroplanes may be able to carry from shore bases or sheltered harbors.

19. High-capacity, high-explosive bombs hitting the upper works of the vessel are disastrous to exposed personnel, serious to light upper works, comparatively slight to heavy fittings such as guns, and negligible to turrets. The effect of direct hits was completely local. The most serious effect of bombs is the mining effect when such bombs explode close alongside and below the surface of the water.

20. In the case of major ships the mining effect of a bomb will be materially reduced due to the ability of the personnel to free the ship of large quantities of water by means of pumps to distribute the excess water through the various compartments and to shore up the water-tight doors and bulkheads which are in most serious danger of carrying away due to water pressure.

21. Aircraft, through the medium of machine guns and fragmentation bombs as well as by high-explosive bombs of high capacity, possesses sufficient offensive power to seriously threaten the exposed personnel of naval vessels unless such vessels are protected by pursuit planes. This emphasizes the necessity for the further protection of personnel and for the provision of aircraft carriers on which such pursuit planes may be based.

22. The effect of the gas bomb has not been determined but it is believed that such bombs possess offensive power which, within the radius of action of the aircraft, is to-day a serious threat to vessels insufficiently protected by aircraft.

Summary of General Conclusions.—23. At present aircraft possesses the following abilities as regards operations with the fleet in areas beyond the radius of action of aircraft based on shore:

(a) Limited assistance to gunnery in the control of fire.

(b) Limited assistance in the service of information and security.

(c) Important strategical and tactical qualities in operations of coast defence.

In adequate quantities they may be the decisive factor in such operations. The availability of these qualities at present depends largely on weather conditions. The radius of action of bombing planes limits their effectiveness against naval vessels to coast defence, or base defence, in which this type is a very powerful adjunct to the present system of coast defence.

24. With reference to the effect of aircraft on future naval construction the Joint Board is of the opinion that:

(a) The mission of the navy is to control vital lines of transportation upon the sea. If no opposition is met from enemy naval vessels this mission can be accomplished without entering an enemy's coast zone within which aircraft based on shore or in sheltered harbors are effective.

(b) Without an effective navy in time of war a nation must submit to an economic blockade fatal to its trade and the importation of necessary materials for the production of war supplies.

(c) If heavier-than-air craft are to be effective in naval warfare they must have greater mobility and since their radius of action is not great, additional mobility must be obtained by providing mobile bases—*i. e.*, aircraft carriers.

(d) So far as known, no planes large enough to carry a bomb effective against a major ship have been flown from or landed on an aeroplane carrier at sea. It is probable, however, that future development will make such operations practicable.

(e) Even in the present state of development the aircraft carrier, as exemplified by the *Argus* of the British Navy, is a type essential to the highest efficiency of the fleet.

(f) Aircraft carriers are subject to attack by vessels carrying guns, torpedoes or bombs and will require, as all other types of vessels require, the eventual support of the battleship.

(g) The battleship is still the backbone of the fleet and the bulwark of the nation's sea defence, and will so remain so long as the safe navigation of the sea for purposes of trade or transportation is vital to success in war.

(h) The aeroplane like the submarine, destroyer and mine, has added to the dangers to which battleships are exposed but has not made the battleship obsolete. The battleship still remains the greatest factor of naval strength.

(i) The development of aircraft instead of furnishing an economical instrument of war leading to the abolition of the battleship has but added to the complexity of naval warfare.

(j) The aviation and ordnance experiments conducted with the ex-German vessels as targets have proved that it has become imperative as a matter of national defence to provide for the maximum possibile development of aviation in both the army and navy. They have proved also the necessity for aircraft carriers of the maximum size and speed to supply our fleet with the offensive and defensive power which aircraft provide, within their radius of action, as an effective adjunct of the fleet. It is likewise essential that effective anti-aircraft armament be developed.

25. The Joint Board recommends that the provisions of the previous orders of the War and Navy departments relative to secrecy concerning the results of the aviation and ordnance experiments be rescinded and that

this report, if approved by the War and Navy departments, be issued jointly to the press.

The report of the joint board of the army and navy on bombing tests off the Virginia capes must remind the layman of the problem of the conflict between the irresistible force and the immovable object.

One of the questions which the tests were to answer was whether the bombing plane, in its present state, was a generally adequate weapon against the battleship of to-day. To this question the report says, No; not unless the plane is operated from a land base:

"No planes large enough to carry a bomb effective against a major ship have been flown from or landed on an aeroplane carrier at sea. It is probable, however, that future developments will make such operations practicable."

What of the bombing plane as an instrument of coast defence, operating from the shore? On this point the plane scores:

"Aircraft carrying high capacity high explosive bombs of sufficient size can sink or seriously damage any naval vessel at present constructed provided such projectiles can be placed in the water close alongside the vessel."

Can battleships be made invulnerable against aerial attack? Only through the ship's offensive defence, the board indicates, for it says that "it will be difficult, if not impossible, to build any type of vessel of sufficient strength to withstand the destructive force that can be obtained with the largest bombs that aeroplanes may be able to carry from shore bases."

So if the United States had enough planes of sufficient capacity no invading fleet could reach our shores unless the enemy ships were equipped with anti-aircraft guns so marvelous as to bring down all our fliers.

As the report remarks, the development of aircraft "has but added to the complexity of naval warfare." It has not junked the battleship, for that must be kept to protect the nation against a blockade. It has rendered it necessary to make the battleship a carrier of planes and to equip it with more and more powerful anti-aircraft guns. Meanwhile the planes must be made bigger, faster and their locating instruments more accurate.

The report does not doom capital ships, but it is for all that a victory for the advocates of the plane as a tremendous weapon in coast defence. The United States could have within a year and at comparatively small cost, a squadron of bombing planes that could fly from a shore base and destroy any battleship that came within gun range of the coast. That's a comfort to know, however the scientific duel between the builders of dreadnoughts and the makers of planes may result in future.

There are naval officers in England and America who think with Admiral Sir Percy Scott and Brig. Gen. Mitchell that submarines and aircraft have rendered the capital ship obsolete. If so, a nation that spent millions chiefly on aviation and maintained a fleet of swift carriers would be a more terrible enemy than a power that placed its dependence upon capital surface ships and neglected aviation. Granting that surface ships are necessary to a navy for police duty in time of peace and for offence and defence in war, it would be judicious not to have too much faith in them. Senator King of Utah said a sound thing when he declared that "these tests demonstrated the vulnerability of the battleship and demonstrated that while it is not obsolete as the principal unit of the fleet its strength and influence have been greatly impaired."

While exceptions may be taken by advocates of the airship as a superior unit to some of the reasoning of the Joint Army and Navy Board's report, it is an honest and courageous summing up of the case by men who felt their responsibility. Speaking of the navy alone, its aviation strength must be expanded to the dimensions of a fleet in the air, which of course will require time, and a sufficient number of swift carriers must be provided. But this will take money—a great deal of it. In the present state of the

country's finances the naval appropriations cannot be increased. Will not Congress have to choose between neglecting aviation, which would be blindness to the lesson of the bombing tests at sea, and calling a halt upon the three-year capital ship program somewhere, so that money to be spent upon it could be diverted to the expansion of naval aviation?—*Aerial Age Weekly*, 5 September, 1921.

THE BACKBONE OF THE FLEET.—The report rendered by the Joint Army and Navy Board on the recent aerial bombing tests off the Virginia Capes confirms the lessons which we drew in our issue of August 6th from these trials. The findings of the report are summed up in the following statement: "The battleship is still the backbone of the fleet and the bulwark of the nation's sea defence, and will so remain so long as the safe navigation of the seas for purposes of trade or transportation is vital to success in war."

The above quotation is one of the ten conclusions, categorically stated, in which the Joint Board, made up of naval and army officers, submitted its findings on the burning issue as to whether bombing aircraft have rendered the battleship obsolete. The argument runs as follows: That if the navy commands the sea routes, the lines of traffic can be kept open without entering the area on the enemy's coast zone which is controlled by aircraft bases on shore. Conversely, a nation without an effective navy must submit to a fatal economic blockade. Again, if heavier-than-air craft are to be effective in naval warfare, they must be able to operate in midocean; and since their own radius of action is limited, they must operate from those mobile bases known as aircraft carriers. Although our navy does not know of any case in which bombing planes, such as sank the *Ostfriesland*, have flown from or landed on an aircraft carrier, it is believed that such operations will in the future become practicable. In this connection, the report quotes the *Argus*, of the British Navy, as a type essential to the highest efficiency of the fleet; but the point is made that since aircraft carriers are subject to attack by vessels armed with guns, torpedoes or bombs, they, like all other subsidiary types of vessels, will require the eventual support of the battleship.

We think this last statement is subject to criticism. A 30,000-ton, 32-knot aircraft carrier would be self-supporting; and for defence against a too-powerful enemy would depend upon her superior speed to enable her to keep out of range. The best of modern battleships cannot hit beyond 20 or 25 miles—an aircraft carrier could maintain a range of 30 miles and send out her bombing planes against the enemy with complete immunity to herself.

The report admits that although the airplane, like the submarine, destroyer, and mine, has added to the dangers to which battleships are exposed, it has not made the battleship obsolete, although the appearance of aircraft has added to the existing complexity of naval warfare.

With the final clause of the report, as indeed with the whole report as such, we are in thorough accord. It states that the aviation and ordnance experiments, conducted with the ex-German vessels as targets, have proved that it has become imperative as a matter of national defence to provide for the maximum possible development of aviation both in the army and navy. These bombing experiments have also proved the necessity for aircraft carriers of maximum size and speed as an effective adjunct of the fleet. It is likewise essential that effective anti-aircraft armament be developed.

Now there is danger, we think, of becoming so greatly impressed with the necessity for building an effective fleet of aerial bombing planes as to overlook the equally important defensive side of the problem. The present popgun arrangements, mounted on warships for the purpose of bringing down airplanes are futile. Shells thrown by 3- and 4-inch gun do not afford a big enough burst and spread; moreover, there remains to be developed

an accurate and swift means for determining the ever-changing position of the enemy. We look to see the day when the 5-inch anti-torpedo batteries of warships will be known as anti-torpedo and anti-plane batteries; which means that they will be mounted on the topmost decks and provided with unlimited elevation.—*Scientific American*, 3 September, 1921.

THE AIRPLANE IN SCIENCE.—The use of airplanes for meteorological observations is not only possible but essential to scientific progress, according to Gabriel Guilbert, Chief of the Forecast Service in the French National Meteorological Bureau, in a recent address at Rouen.

"The basis of good forecasting is first of all good observation," he said. "Exact information and a capable staff of workers will not suffice; there must be a considerable number of stations, placed at carefully selected points and under professionally trained meteorologists. Our daily charts, though the largest prepared anywhere in the world, must be developed, and in this the wireless telegraph will enable us to record observations in the north, coming from Spitzbergen or even nearer the Pole, from the east, from Siberia, the Caspian Sea, Asia Minor, from tropical lands to the south, and in the west from stations in Greenland and the New World, as well as maritime observations from transatlantic liners.

"Last of all, scientific progress demands the utilization of the airplane. That is in the present and the future the best means of meteorological exploration. The aviator can determine the physical nature of different clouds, their extent, altitude, relative positions and motion. He alone can watch 'on the spot' the secrets of the formation of rain and storm. And if artificial rain is not an idle dream, the aviator can bring it about. The entire atmosphere is comparable to-day to an unexplored desert; and through airplanes new foundations may be laid for the development of scientific weather forecasting."—*The N. Y. Times*, 29 August, 1921.

THREE NEW FOG DEVICES to overcome the drawbacks of mist and fogs to airmen are stated to be under discussion by British authorities. The first consists of the "laying along the route traversed by the airway of a powerfully charged electrical cable. This automatically sends up into the air a constant series of signals." By keeping his machine in such a position that the strength of the signals is kept constant the airman is assured that he is flying along the cable line. The second makes for safety in landing when the ground is not visible, and consists of a wire, with a weight attached, which is lowered from beneath the machine; when the weight touches the earth the airman learns that it is time to "flatten out" his machine. The third is called the "artificial horizon." It is "a gyroscopic instrument which shows an artificial horizon line always in front of the pilot and enables him to detect instantly when his machine is heeling over too much sidewise in its relation to the real horizon, which is temporarily invisible. A tiny model airplane poised above the artificial horizon line mimics precisely the movements of his own machine.—*Scientific American*, 3 September, 1921.

STEAM ENGINES FOR AIRSHIPS.—Invention of a system of steam propulsion for airships is claimed by Captain W. P. Durtnall, who was a British naval officer during the war, and up to a year ago staff captain in the chief mechanical and electrical engineer's department of the Royal Air Force.

It is maintained that the new system will function at altitudes hitherto unattainable with the ordinary type of internal combustion engine.

The invention is said to do away completely with the ordinary boiler, the steam being generated by means of internal combustion power or heat energy. The superheated steam heat energy is supplied to special steam motors which are reversible and can be controlled from a central control station. Only heavy oil is used as fuel, and it is claimed that the driving

machinery can be safely placed inside the frame of the airship instead of in separate gondolas outside, thus bringing about a great reduction in air resistance and consequently reducing the power required for propulsion.

The engines or "steam motors," as Captain Durtnall calls them, are of the double-acting type, requiring no flywheels.—*Aerial Age Weekly*, 5 September, 1921.

TRANSATLANTIC FLYING SHIPS.—According to the London *Daily Mail* the Fairey Company, builders for the British Air Ministry of the great Titania flying boats, have in hand plans for giant transatlantic flying ships, driven by specially designed 4000-horsepower engines, which will have luxurious accommodation for as many as 100 passengers, in addition to fuel, crew and stores. They will, in fact, be air liners, with great hulls which, seen without their wings, one might mistake for some specially designed craft for use on the surface of the water. Starting from the lower reaches of the Thames, such vessels will be able to make a non-stop flight to New York in very little more than 40 hours; while calculations which have just been made show that with a sufficient fleet, well patronized, the fare by flying should be little, if any, more than by steamship. Conditions in the flying ships will approximate almost exactly to those of first-class steamship travel. Guided on their course by directional wireless, informed in advance of weather changes, and with a motive plant which is practically immune from the risk of breakdown, they will offer not only speed and comfort but also safety.—*Aerial Age Weekly*, 5 September, 1921.

THE GREATEST AERIAL DISASTER.—When the world's largest dirigible exploded, collapsed and fell flaming into the River Humber burning to death or drowning 17 American and 27 British officers and enlisted men, it meant "the end of experiments with airships of the *Zeppelin* type," in the opinion of Hiram Percy Maxim, inventor and aviation enthusiast. "The great cost of constructing a 700-foot rigid dirigible," agrees the New York *Sun*, "has perhaps checked the progress of development in this type." Rear Admiral Moffett, chief of naval aviation, however, maintains that the American Navy "will 'carry on,' build and operate as many ships of this type as may be authorized by Congress." In fact, at the present time the *ZR-1*, sister ship to the British *R-38* (which was to have become the *ZR-2* after the successful completion of her trails) is now in process of construction in this country. "It seems, however, that at the present time, like Frankenstein, men build such a giant only to have it turn upon them and to destroy them," notes the Hartfort *Courant*. In any event, says the Springfield *Union*, "this tragic instance—the world's worst aviation disaster—clearly shows that the construction of these immense dirigibles involves problems yet to be mastered." Moreover, contends the New York *Herald*, "they must be mastered at home, where we must eventually make these airships for ourselves. Why should the government spend $2,000,000 for a British dirigible? Yankees are good hands at such work."

As the *R-38* had not been accepted by the navy, the investigation of the cause of the disaster probably will be undertaken by the British Air Ministry, it is pointed out. Nor, it is said, will the United States be expected to pay any part of the loss. That the *R-38* was considered a "lemon" and a "flivver" by several members of the crew which was to have brought her over the Atlantic, is now revealed by the New York press. Although at this time it is not known whether the collapse of the dirigible was due to faulty design, mechanical trouble, fuel or gas leakage, structural weakness, fire or the bursting of gasoline feed pipes, "time and again news of defects in the airship were published," we are reminded by the New York *Evening Mail* as we read in a New York *Times* editorial:

"Defects in her construction had come to light, although little was said about them officially. In July an intermediate plane and four intermediate

braces showed weaknesses. It was then reported that she had a tendency to 'drag amidships.' Early in August some control wires loosened when she was running under half power. The balanced elevators and rudders were said to be 'overbuilt'; a rib here and there gave way; and extensive repairs were necessary. There was some talk of engine trouble. The fact is, the dirigible was in the repair shop a good deal of the time, but the constructors were sanguine that she could be strengthened and made airworthy."

More specifically, we are told by the New York *Tribune:*

"Prior to her final flight the *ZR-2* (as she was to have been rechristened by the U. S. Navy) had made three short trial journeys. On each of them serious defects were observed immediately after all of the craft's six engines were advanced to full speed.

"On her first trial flight the airship was compelled to descend before her scheduled time because control wires loosened quickly under half-speed flying. The second flight had to be shortened in order that the rudder surfaces could be reduced.

"The third trial flight disclosed for the first time that the giant hull was structurally defective. On this flight the airship attained a speed of 50 knots for the first time. This speed was 10 knots less than the contract cruising speed. Nevertheless, even at this reduced speed the strain was so great that some of the vessel's ribs weakened and gave way. Only four of the six engines were running at the time the weaknesses developed.

"It was after this flight that the dirigible was taken back to Howden and extensive repairs made with a view to strengthening the hull."

It was expected that the *R-38* would be the forerunner of a fleet of war and commercial dirigibles. She carried a wireless set capable of sending messages 1500 miles; all parts of the ship were connected with the commander's gondola by telephone; the exhaust from the engines was utilized for cooking purposes; the men had bunks instead of hammocks; the ship was electrically lighted throughout; in fact, as one writer puts it, "nothing was overlooked in making the vessel an air-floating home." True, her compartments were not filled with helium gas, which is non-inflammable, but with hydrogen gas, but this is because the United States has the only known supply of helium gas, and even we do not produce it in large quantities. Had this gas been used, experts agree, there would have been little, if any, loss of life. As the New York *World* points out, "inflammable gas is never safe in the vicinity of a gasoline engine or an electrical storm." Continues *The World:*

"The theory of the dirigible remains so sound essentially that it will not be abandoned, but the production of an inexpensive, non-inflammable gas must precede further rapid development. As matters stand, the necessary experience in piloting and handling airships is brought too often at the price of the lives of the crew. If the business of experimentation were put on a more scientific basis and confined for a while to laboratory tests more progress might be made and fewer lives lost at the same time. As Germany pretty well proved during the war, the dirigible can be both manageable and effective when correctly built and well handled. It has a future."—*The Literary Digest,* 3 September, 1921.

BIGGEST NAVY BLIMP BURNS WITH THREE MORE.—Twenty minutes before she was to have started for the hangar built at Lakehurst, N. J., for the *ZR-2,* the naval balloon *D-6,* the largest and newest non-rigid dirigible possessed by the navy, burned with her hangar and three other balloons at the Rockaway Point Naval Air Station yesterday morning.

No lives were lost, but Machinist's Mate Donald B. MacKay, in the car when the fire started, was severely burned. MacKay, his clothing in flames, escaped by climbing down a rope ladder to the floor of the hangar just as the fire began to lick up the sides of the huge envelope.

The *D-6* was fully inflated and contained about 190,000 cubic feet of hydrogen gas. The other balloons, not inflated, were the kite balloon *A-P* and two small dirigibles, the *C-10* and the *H-1*, which broke away from its moorings about two weeks ago and was found in Westchester County.

Balloon was Navy-Built.—The *D-6* was 200 feet long and 50 feet in diameter fully inflated. She was propelled by the two 125-horsepower Union type motors, and could make 50 miles an hour. She had a lifting power of about 10 tons. The *D-6* carried 200 gallons of gasoline and had a cruising radius of 1000 miles. She was assembled at the Rockaway Point Station under the direction of Lieutenant Bausch.

The gondola and engines were built at the League Island Navy Yard in Philadelphia and the balloon was made at the navy balloon plant in Akron, Ohio. The *D-6* was equipped with the limousine type of gondola, completely enclosed, which made it possible, the authorities believe, for the men in the hangar to escape before the balloon ignited. The trip to Lakehurst would have been her maiden voyage, although she had been taken for several short test spins over Jamaica Bay and Coney Island.

Before the *ZR-2* disaster it had been planned to sail the *D-6* to Lakehurst, where she would have been used as a training ship for the crews of the *ZR-2*. Her hangar was built in 1917. Its dimensions were 225 by 125 by 80 feet, built to house two ships the size of the *D-6*. Constructed of steel and glass, it was a total loss. The value of the *D-6* was put at about $100,000. No estimate was given of the value of the other balloons or the hangar.—*The N. Y. Times*, 1 September, 1921.

THE AMERICAN AIRSHIP.—The destruction by fire of the *D-6*, the largest American naval dirigible, and of two smaller lighter-than-air craft, following so closely upon the loss of the *ZR-2*, invites attention to America's part in the development of the airship. As in the case of the airplane, the country's part in the development of this means of air transportation has been slight. The Wright brothers had to go to France for sympathetic aid during the pioneer airplane days, and their experience discouraged Americans who were interested in Germany's efforts to bring the *Zeppelin* to perfection.

The war found the United States, with inventive genius, money and manufacturing facilities, far behind even second-rate powers in aerial navigation progress. Under the stimulus of war, the country tried to catch up, but failed. Its armies in the field paid a tremendous price in blood, because at the outset of the war the American Army had only two serviceable airplanes. The war lesson was, however, forgotten as soon as the Armistice was signed. The American factories equipped to make aircraft of all kinds are now receiving little encouragement from the government. Even the experiments in the use of airplanes and dirigibles in naval warfare off the Virginia capes have not aroused the government.—*The Indianapolis News.*

WOULD USE HELIUM TO FLOAT AIRSHIPS.—Further experimental work in the production of helium as a substitute for hydrogen gas for dirigibles is urged by Van R. Manning, former director of the United States Bureau of Mines and new Director of Research for the American Petroleum Institute. The terrible loss of life in the *ZR-2* disaster at Hull, England, Mr. Manning declared yesterday, accentuates the need for an intensive development of the helium here.

"The military and commercial use of helium for dirigibles," said Mr. Manning, "is generally recognized, although to date no practical utilization of this gas has been made except by the government. In the spring of 1917, as the Director of the Bureau of Mines I approved a preliminary investigation as to the possibilities of the production of helium as a war measure, and as a result a co-operative effort was instigated by the Interior, Army and Navy departments looking toward the solving of a problem

which was important to our own and our Allies' interests. Prompt and quick results were desired.

"It can be said to the credit of these branches of our government that satisfactory results were obtained, although not in time to put into actual service dirigibles filled with helium. Ample funds were allotted by the Army and Navy Departments to the Bureau of Mines, Interior Department, and experiments were immediately begun with three processes. One process was proved to be successful, another not wholly successful and the third plant has been operating experimentally up to a few weeks ago. The fact is that the government is now operating a large helium production plant, with a capacity of 30,000 cubic feet of helium per day.

"Major P. E. Van Nostrand of the United States Army, who was to have been one of the officers on the ill-fated *ZR-2*, was one of the collaborators in the development of this work and fully appreciates the importance of helium for dirigibles and balloons, is credited by the press with the statement that 'had the ship been filled with helium it is doubtful if such an accident could have happened.'

"As one who had to bear the responsibility for the experimental work until a year ago, I cannot emphasize too strongly the statement that the government expenditures, large as they were, in separating helium from natural gas for use in dirigibles, whether for military or commercial purposes, have been thoroughly justified, and it will be obvious to any one who has even a superficial idea of the uses for helium that ample funds should be forthcoming from the government and private sources to carry on further experimental work. The government is now the chief user of helium, and I should like to direct the attention of our country to the importance of continuing active and immediate development of the rigid airship and helium programs previously undertaken by Congress to the end that the officers and men who forfeited their lives may not have died in vain."

The story of helium was described by Mr. Manning as "one of the romances of science." "It may be of interest at this time," he said, "to know something of helium and the development in the production to date. Scientists admit that its discovery was one of pure science. It was first discovered in 1868, in India, while scientists were making observations of an eclipse of the sun. Scientists agree that the occurrence of helium is in the air, in sea and river water, in rocks and minerals, in the stars and sun, in mineral springs, in geysers and in volcanic gases, but the only quantities on a large scale can be recovered from the natural gas of the United States."—*The N. Y. Times*, 4 September, 1921.

THE DIRIGIBLE'S USES.—The comment often heard upon the lamentable destruction of the dirigible *ZR-2* takes the form of criticism of our government for acquiring at great cost a type of airship that has so often succumbed to storms and enemy attack. It is said that the government should put all its money into seaplanes, which are much more useful and much cheaper. Why, ask the critics, did the United States contract to buy a British dirigible when there were so many competent American constructors and mechanics to build airships here? The answer is that the Navy General Board recommended that 10 rigid dirigibles be added to the fleet, and that as the British *R-38* was in the market a beginning could be made with that ship at a time when the British possessed the only hangar in which a dirigible like *R-38* could be built. The United States has since completed a hangar and will make its own lighter-than-air ships. One about the size of the *R-38* or *ZR-2* is now building. It must be understood that when the contract was made in 1920 to take over the *ZR-2* our designers were learning from the British, who previously had obtained the German secrets of construction.

The naval authorities believe that dirigibles are valuable auxiliaries. "For coast patrol," says Woodhouse in his "Textbook of Naval Aero-

nautics," published in 1917, "the *Zeppelin* is very efficient indeed. For submarine hunting, convoying ships and patrolling ship channels a single *Zeppelin* can easily do the work of 50 airplanes, and can do work which no airplanes can do at present." Dirigibles are thought to be indispensable for "spotting" mines and signalling the presence of submarines to the fleet. It must be considered that a ship like *ZR-2* would have a cruising radius of 5000 miles. She could move in any direction and leave her base for a long time. At night the dirigible is master of darkness, while the airplane is uncertain of her course. The dirigible can carry many tons of explosives; on a raid stealthily carried out she could demolish camps and lay fortified cities in ruins.

The *ZR-2* was to have been a formidable war machine. She was to be equipped to carry four bombs of 520 pounds and eight of 230 pound. She was to have a battery of 14 machine guns and a one-pound automatic gun for defense. So spacious were her crew accommodations that she was to serve as the aerial general headquarters of the fleet. There were to be telephone communications on board and a wireless system. A dirigible like her is now building at Lakehurst. The American constructors believe that their ship will be an improvement upon the *Zeppelin* and the best British dirigible.

There will, of course, be no halt in the work at Lakehurst because *ZR-2* proved a total loss and valuable officers perished. A naval policy may be changed because it is proved to be wrong, but it is not abandoned because casualties have occurred in carrying it out. The airplane, in the opinion of some specialists, has rendered the battleship obsolete. Nevertheless, the battleship is to be retained because a greater number of specialists contend that it is the most useful unit of a fleet. But no one will argue that the airplane has "scrapped" the dirigible. The lighter-than-air ship has many uses in a sea campaign and can be very destructive on land. The building of dirigibles will go on, although they may be made smaller for the sake of greater structural strength and security.—*The N. Y. Times,* 26 August, 1921.

AIRCRAFT AND LIGHTNING.—An experienced flier discusses the possibility of aeroplanes in flight being struck by lightning during a storm in a recent issue of *Illustrierte Flug-Welt.* His remarks are based on some 70 flights under such circumstances and on general principles. He shows that no danger is to be expected in the first place if the machine is not in the direct line of the discharge, and in the second place, even if it is, it is not likely from the nature and distribution of the conducting metal portion that danger due to fire will arise. Out of 30 cases where the machine was struck directly, the writer maintains that there were no evil effects, while in all known cases in Germany where a machine fell during a storm there was no evidence of scorching of parts or melting of metal.—*Aerial Age Weekly,* 22 August, 1921.

A SURVIVAL OF THE FITTEST AMONG AIRPLANES.—The French public, which has ever taken a keen interest in the advancement of aviation, was recently treated to an interesting competition among a number of large passenger airplanes, the object of which was to determine their respective merits for regular passenger service. The main factors of the competition were the maximum of safety, of speed, of general performance, and of dependability over a protracted period of service. First of all, a series of elimination trials was conducted, only the surviving machines being permitted to take part in the final and true test in the form of a flight of 2700 miles.

Under control of the well-known pilot Gonin, the Farman *Goliath* made a remarkable flight. It carried a load of over 6000 pounds. The average flying speed over the 2700-mile course was upward of 80 miles per hour, with the motors turning at 1300 revolutions per minute. The machine

scored a veritably perfect performance; indeed, not even a single wire had to be adjusted upon its return, and the *Goliath* was said to be ready to undertake a new flight without a single repair or tuning up.

It will be recalled that the Farman *Goliath* as a type has been known for the past two and one-half or three years, or shortly after the termination of hostilities. However, heretofore this type has had but two motors of 250 horsepower each. The addition of a third engine should make for even greater reliability and greater speed. The two-engined *Goliaths* have distinguished themselves by the Paris-Dakar flight with seven passengers, Paris-Constantinople, and the regular commercial services between Paris and Brussels and Paris and London.—*Scientific American*, 3 September, 1921.

NEW SYSTEM OF DETERMINING GROUND SPEED OF AN AEROPLANE IN FLIGHT.—A mathematical system for determining the ground speed of an aeroplane during flight, as well as wind direction and velocity at any altitude, which shows considerable promise of proving an interesting and highly useful solution of these heretofore difficult problems in the longer cross-country, photographic, and bombing operations, has recently been evolved by Major Junius W. Jones, A. S., who has just completed a series of tests in these subjects incidental to his routine air missions as a student pilot at the Air Service Observation School, Post Field.

The system devolves upon the known geometric relationship between three factors, all of which may be readily determined by the pilot whilst in flight; namely, air speed, drift angle, and time each way between any two nearby points on the ground. An exact mathematical height above the earth, independent of the data given at the moment by the aneroid instrument, may also be determined by the system worked out by Major Jones, and would doubtless prove of great advantage over the altimeter, which is necessarily limited in accuracy by zero orientation at the home landing field, in cases where exact scale photography were to be carried out over distant objectives of varying elevation above the sea level, or when, in artillery work, the Battery Commander is requested to lay his guns on the plane, the exact altitude of the ship above the designated target forming the base line of triangulation by which accurate range may be determined.

To reduce the application of his system to a practical basis so that the pilot's attention need not be absorbed in calculation, which the inventor modestly admits must lead to realms somewhat abstruse before the integrations employed may be directly applied, Major Jones has resolved all formulæ into a single simple chart, consisting of a series of arcs with their intersecting and correlated curves, a photostat copy of which has already been published in practical scale for use in the cockpit. By this chart it is necessary only for the pilot to adapt the simple arithmetical factors of time, airspeed and drift angle to a base line of the chart, which is then followed through its various intersections graphically to obtain the desired information concerning ground speed, wind direction and velocity, compass course, or altitude, etc.—*Aerial Age Weekly*, 3 September, 1921.

IMPROVED AIRPLANE PROPELLER.—Announcement is made in the *Times* of the invention of an improved type of airplane propeller whereby engine power necessary for driving the airplane will be lessened and the vibration of the machine will be much reduced. The new type of propeller arises from the addition of a number of "veins" or flanges made of aluminum to the existing type of propeller. These "veins" are about six inches in height and run parallel across the surface of the propeller at a distance of about one foot from each other. There are eight at the drive side, four at each end of the blade, and six on the wind side in similar positions. It is claimed that by this arrangement the air is properly directed past the propeller blade faces, with the result that there is an avoidance of the air

losses from the blade ends, which through natural causes take place in the present type of propeller, making possible a maximum thrust with a minimum expenditure of power.—*Scientific American*, 3 September, 1921.

NAVIGATION AND RADIO

THE DISTANT COMPASS.—For a long time, small fluid compasses were almost exclusively used on aircraft. Such a compass consists essentially of a number of comparatively weak magnets which, supported by a hollow float, turn on a needle point in a vessel filled with alcohol and water. This would answer for ordinary use, if there were on the aircraft no iron parts and no other magnets, like starters, magnetos, dynamos, etc.

The compensation of these disturbances by small magnets is only a makeshift and by no means frees the compass readings from error. The many neighboring movable iron parts, like steering devices, weapons, tools, bombs, etc., even key-rings, knives and the like in the pockets of the occupants, exert, according to their size and proximity, a varying influence on the compass readings which, on the aircraft, are hardly controllable and cannot be corrected, any more than the constantly varying influence of the above mentioned magnets.

Every deviation of the aircraft from the horizontal position, in either a lateral or longitudinal direction, likewise exerts an influence on the compass readings. Thus there are generated, especially by sudden changes of position in curved flight, oscillations of the card which may even increase to the complete revolutions dreaded by every aviator.

The oscillations of the compass card, due to those magnetic and mechanical influences are indeed deadened by the compass liquid, but this friction is operative not only in the indicated instances, when the card, with the magnets, oscillates with reference to the compass vessel, but also when the system is at rest and only the vessel turns, as in every curving flight. In the latter case, the card is also carried along and indeed just so much more, the weaker the magnet system and, accordingly, its directive power. On the other hand, the greater the directive power of a magnet system, the greater are its errors of deflection from neighboring masses of iron. These errors call for stronger compensation magnets which, the stronger they are, the more they weaken the directive power of the system. Out of this endless circle there was yet on an aircraft only the unsatisfactory compromise. The employment of a reliable magnet compass, free from objections, was impossible and one was compelled to make the best of inaccurate and unsatisfactory compasses.

An improvement of the properties of the aeroplane compass to real serviceableness in aerial navigation is only possible then, when the disturbing causes are eliminated. The navy prescribes for every compass on shipboard a minimum distance within which there must be no iron. This is impossible on an aeroplane, since there is no such amount of room free from iron from within view of the pilot or observer. It is difficult to install a compass on an aeroplane at all, on account of the limited space.

On the other hand, the remedy by placing the compasses in magnetically somewhat more favorable position, for instance, on the upper or lower supporting deck, presents many other disadvantages: inconvenient reading of the compass, difficult and inaccurate steering by such a distant instrument, compulsory cessation of the possibility of taking bearings, as also the impossibility of using adjustable indicators and other accessories, mistakes in reading oblique and side views, insufficient protection of compass against cold and wet, as also against the force of the air current which, in such a location, often tilts the compass or even upsets it. Moreover, only small compasses with weak magnets can be used, since a higher directive power cannot be employed, for reasons already given, and the still unavoidable proximity of iron and because the limited space prevents the installation of larger compasses.

Against the use of the ordinary compass on an aeroplane there are various further practical considerations. Steering by a reference mark and the general use and complete utilization of such a compass requires too much experience on the part of the pilot, especially of one with little or no knowledge of navigation, while even an experienced and educated pilot finds it too strenuous to watch the card, with its finely divided scale, and, at the same time, attend to the numerous details of managing the aeroplane,

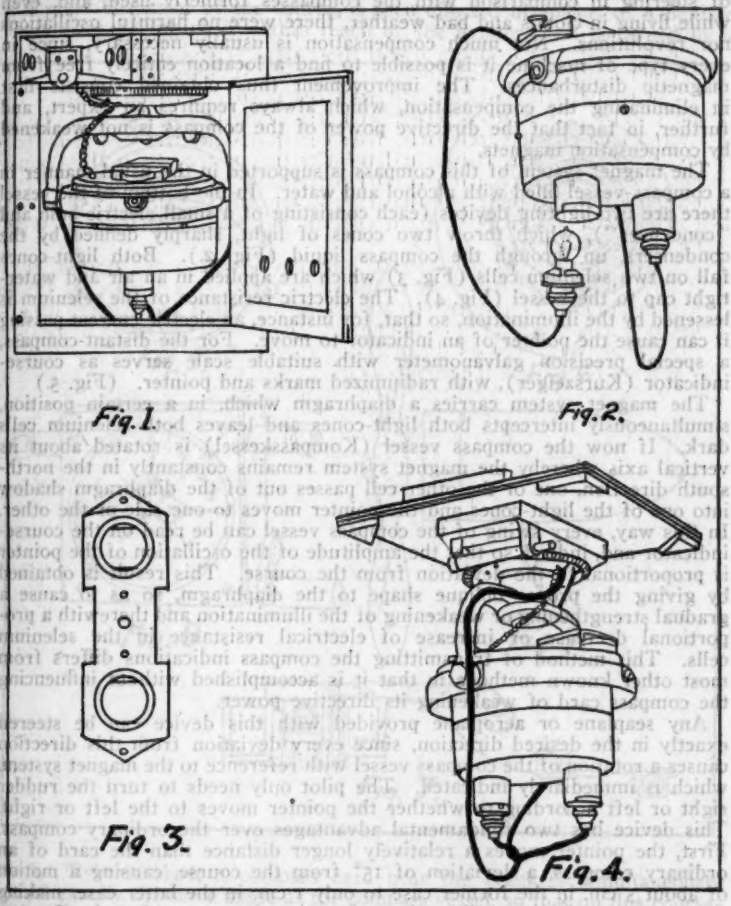


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

observing, fighting and keeping constant watch of the ever-increasing number of instruments. The increasing demands on the pilot emphasize the need of direct communication between him and his observer, in order to do away with time-robbing attempts at speech, signals and makeshifts.

For solving all these problems, there is now a new device, the "distant-compass" constructed by Carl Bamberg, Friedenau, and improved in 1918 by the Seaplane Division and practically tested in comprehensive experiments and use at the front. Since this compass does not need to be in sight of the aviators and can be located far from all iron parts, it can be as

powerful as those used on ships. This compass is free from error down to the fraction of a degree and at least as reliable as those on large ships, The most favorable location on the ordinary type of aeroplane is from one to one and a half meters behind the rear seat in the fuselage, where the compass, enclosed in a wooden case (see Fig. 1), is protected from the wind and weather. The magnet system is the same as demonstrated its stability in the submarines. Its use on aeroplanes has greatly increased the accuracy of steering in comparison with the compasses formerly used, and, even while flying in clouds and bad weather, there were no harmful oscillations nor revolutions. Not much compensation is usually necessary, since in every type of machine it is possible to find a location entirely free from magnetic disturbances. The improvement thus obtained consists first in eliminating the compensation, which always requires an expert, and further, in fact that the directive power of the compass is not weakened by compensation magnets.

The magnet system of this compass is supported in the usual manner in a compass-vessel filled with alcohol and water. In the bottom of the vessel there are two lighting devices (each consisting of a small electric bulb and "condenser"), which throw two cones of light, sharply defined by the condensers, up through the compass liquid (Fig. 2). Both light-cones fall on two selenium cells (Fig. 3) which are applied in an air and water-tight cap to the vessel (Fig. 4). The electric resistance of the selenium is lessened by the illumination, so that, for instance, an electric current passing it can cause the pointer of an indicator to move. For the distant-compass, a special precision galvanometer with suitable scale serves as course-indicator (Kurszeiger), with radiumized marks and pointer. (Fig. 5.)

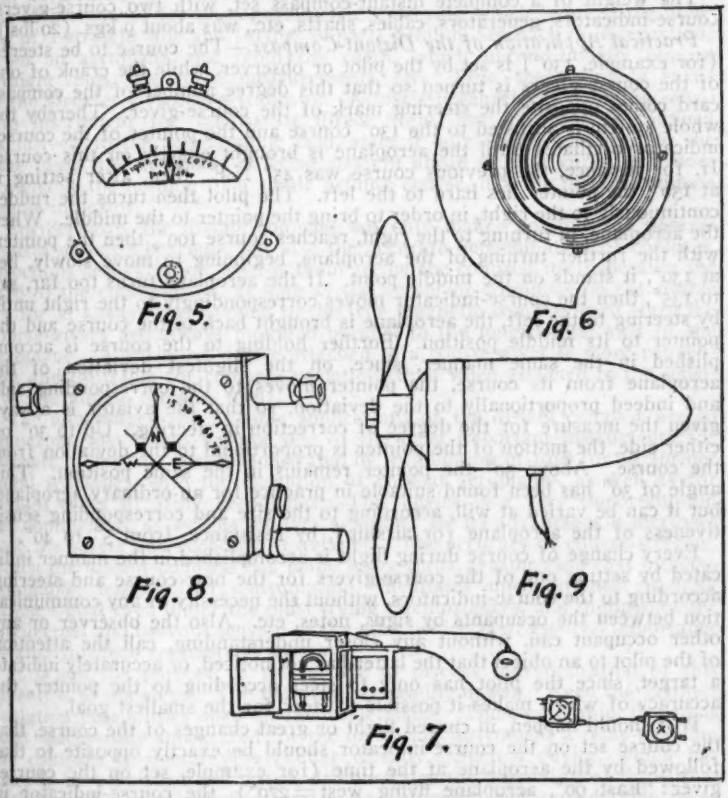
The magnet system carries a diaphragm which, in a certain position, simultaneously intercepts both light-cones and leaves both selenium cells dark. If now the compass vessel (Kompasskessel) is rotated about its vertical axis whereby the magnet system remains constantly in the north-south direction, one or the other cell passes out of the diaphragm shadow into one of the light-cones and the pointer moves to one side or the other. In this way, every swing of the compass vessel can be read on the course-indicator and, indeed, so that the amplitude of the oscillation of the pointer is proportional to the deviation from the course. This result is obtained by giving the proper oblique shape to the diaphragm, so as to cause a gradual strengthening or weakening of the illumination and therewith a proportional decrease or increase of electrical resistance in the selenium cells. This method of transmitting the compass indications differs from most other known methods in that it is accomplished without influencing the compass card of weakening its directive power.

Any seaplane or aeroplane provided with this device can be steered exactly in the desired direction, since every deviation from this direction causes a rotation of the compass vessel with reference to the magnet system, which is immediately indicated. The pilot only needs to turn the rudder right or left according to whether the pointer moves to the left or right. This device has two fundamental advantages over the ordinary compass. First, the pointer moves a relatively longer distance than the card of an ordinary compass, a deviation of 15° from the course, causing a motion of about 5 cm. in the former case to only 1 cm. in the latter case, making the accuracy of the reading about five times as great for the former. Second, this compass, like all the other instruments on the aeroplane, is read on a fixed scale by means of a mobile pointer and thus spares the aviator the special thought required, on all other instruments for reading the mobile card scale with reference to a fixed steering mark.

If the compass is rotated a certain angle, say 65°, with reference to the longitudinal axis of the aeroplane, then the new course, if flown according to the course-indicator, will evidently deviate 65° from the original direction, since one of the selenium cells receives the light and thereby brings the course-indicator to one side. until. by the turning of the aeroplane

itself 65°, it comes again into the shade of the diaphragm. At any time during flight, any desired new course can be established by turning the compass vessel the desired angle with reference to the longitudinal axis of the aeroplane. The compass vessel had for this purpose a suspension device which can be readily rotated by mean of a worm gear (Fig. 4).

For this purpose, the compass is placed in the rear part of the fuselage or other iron-free location. The turning of the compass vessel, and with it the establishment of the course, is then effected by means of a flexible shaft (Fig. 7) which is within reach of the aviators and is turned by a



crank. By this shaft a compass card near the crank is simultaneously turned exactly the same angle as the compass vessel, so that on this course-giver (Kursgeber) (Fig. 8), the angle and thus the compass course can be read. Naturally, in such a system with a flexible shaft, several course-givers and course-indicators can be installed, for the pilot and observer and any other persons in any part of the aeroplane, who are thus enabled to observe and assist in the navigating.

The heat generated by the electric lamps prevents the freezing of the compass liquid, even in very cold weather. The minimum current required for the compass installation is about 10 watts. This current can be obtained by connecting the system with a source of electric current already on the aeroplane, but is usually supplied by a small airscrew double generator of

especial reliability (Fig. 9), specially constructed for this purpose, with an output of 40 volts 6 milliamperes for the indicator circuit, which flows through the selenium cells, and 8 volts, 2 amperes for the electric lamps, and weighs only 1.8 kg. (4 lbs.). The tension of the generator is kept constant between 3700 and 7500 r. p. m. by an automatic regulator according to the Sumner principle. The best location for the generator is in the air current from the propeller. The number of r. p. m. required for the work of the compass system was found in a test to be about half the r. p. m. of the engine.

The weight of a complete distant-compass set, with two course-givers, course-indicators, generators, cables, shafts, etc., was about 9 kgs. (20 lbs.).

Practical Application of the Distant-Compass.—The course to be steered (for example, 130°) is set by the pilot or observer, while the crank of one of the course-givers is turned so that this degree number of the compass card comes opposite the steering mark of the course-giver. Thereby the whole system is adjusted to the 130° course and the pointer of the course-indicator oscillates until the aeroplane is brought exactly on this course. If, for instance, the previous course was 45° N.E., then, after setting it at 130°, the pointer lies hard to the left. The pilot then turns the rudder continuously to the right, in order to bring the pointer to the middle. When the aeroplane, in turning to the right, reaches course 100°, then the pointer, with the further turning of the aeroplane, beginning to move slowly, lies at 130°, it stands on the middle point. If the aeroplane turns too far, say to 135°, then the course-indicator moves correspondingly to the right until, by steering to the left, the aeroplane is brought back to the course and the pointer to its middle position. Further holding to the course is accomplished in the same manner, since, on the slightest deviation of the aeroplane from its course, the pointer moves to the corresponding side and indeed proportionally to the deviation, so that the aviator is always given the measure for the degree of correction in steering. Up to 30° on either side, the motion of the pointer is proportional to the deviation from the course. Above 30° the pointer remains in the same position. This angle of 30° has been found suitable in practice for an ordinary aeroplane, but it can be varied at will, according to the size and corresponding sensitiveness of the aeroplane (or airship), by resistance, from 5° to 40°.

Every change of course during flight is accomplished in the manner indicated by setting one of the course-givers for the new course and steering according to the course-indicators, without the necessity of any communication between the occupants by signs, notes, etc. Also the observer or any other occupant can, without any closer understanding, call the attention of the pilot to an object that the latter has not noticed, or accurately indicate a target, since the pilot has only to steer according to the pointer, the accuracy of which makes it possible to steer for the smallest goal.

If it should happen, in curved flight or great changes of the course, that the course set on the course-indicator should be exactly opposite to that followed by the aeroplane at the time (for example, set on the course-giver: East 90°, aeroplane flying west = 270°), the course-indicator in this special case, when the difference is just 180°, stands in its middle position, which results from the two selenium cells being located at 180° apart. This position, however, hides no possibility of error, because it is immediately evident that likewise (following from the construction) the course-indicator swings in the opposite direction than when the aeroplane is flying on the course set. If the aeroplane, as assumed in the example, is flying west and turns only 1° to the right of this course, the pointer swings to the left and the pilot must therefore steer to the right. Thereby he continually goes further to the right from his false west course, for the pointer remains on the left until the aeroplane is again on the east course for which the course-giver is set. Only then is the pointer again in its correct middle position. The second and opposite middle position of the course-indicator makes it possible therefore for an aeroplane that has

deviated by a large angle (around 180°) from its correct course, to be always shown the smaller angle and therefore the shorter way back to its correct course. Every aviator must therefore become accustomed to following the course-indicator blindly, then, whether in clouds or fog, even in battle, after completely losing his bearings, he will immediately return to his correct course, without danger of the compass whirling, even from the most violent motions of the aeroplane.

The sensitiveness of the pointer, which indicates deviations of fractions of a degree from the direct course, enables the aviator to fly straight ahead and horizontally in clouds and at night. Only this condition enables the use of aeroplanes for photogrammetric surveying which requires the holding of a straight line and further imparts genuine accuracy to observations from an aeroplane and from the earth, which unconditionally require straight lines, like speed measurements, etc. True, there already exists in the Drexler Gyroscope Indicator (Kreiselssueranzeiger) a highly sensitive instrument for facilitating direct flight, but its value is confined exclusively to the aerodynamic field, since it only shows whether, for the time being, the aeroplane is flying straight ahead or in a curve, and does not enable the holding of a single definite course, like the distant-compass course-indicator.

Furthermore, the distant-compass not only makes possible the general control of one's bearings, but also the accurate determination of compass, directions and variation, even without seeing the compass itself, because the card of the course-giver, as long as the aeroplane continues on the course set for it, always corresponds to the true magnetic compass card since the course-givers are always mounted parallel to the longitudinal axis of the aeroplane. A variation device attached to a course-giver is more convenient and utilizable for compass variations than when attached to the sensitive and mobile compass itself.

The advantages and possible applications of the distant-compass are so numerous that it has become one of the most important instruments for aircraft. This was also demonstrated by its adoption in 1918 for all former naval seaplanes, with the exception of combat aeroplanes, as well as for certain types of army aeroplanes. This device is a very important aid for commercial, as well as military aviation. By its advantages it increases both the safety and economy of aviation. The accuracy of course-steering, which the distant-compass has made many times greater than that hitherto attainable, lessens fuel consumption, facilitates unconditional reaching of one's goal even under the most trying circumstances, and diminishes the intellectual and nervous tension of the pilot, which is of especial importance in long distance commercial aviation.

It is not the purpose of this article to discuss the application of this invention to sea ships. The parallels are readily drawn. Even the farthest evolution possibilities open up favorable vistas. Thus, on a ship, there has been successfully substituted for the indicating instrument a relay enabling the compass to operate the rudder directly. Such a device, which has already been finished and tested, demonstrates the possibility of dispensing with the pilot and replacing him by an automatic and considerably more accurate steering-compass. The lateral steering of an unmanned aeroplane rests on the same principle.—By Walter Friedenburg.—*Translated for the National Advisory Committee for Aeronautics, by D. M. Miner.—Aerial Age Weekly*, 29 August, 1921.

COMPASS CONTROL MIGHT HAVE AVERTED DISASTER.—Commenting on the Alaska disaster with its toll of human lives, the *Shipping Register* observes that there is one feature of that wreck that has been overlooked in the official inquiry. At his hand, and absolutely free, the master of the *Alaska* had for instant use a service which would have told him within a few hundred yards his exact position. That is the compass control service of the United States Navy.

All that the captain of a ship has to do, at any point off the Pacific Coast of the United States, is to notify his wireless operator to send out a signal for compass control direction. In reply and within a few minutes the radio operator receives directions.

There is no excuse for ignoring this service. Had the *Alaska* inquired for angular position just before she struck she could not but have avoided the treacherous shore.—*The Nautical Gazette*, 3 September, 1921.

RADIO SERVICE BETWEEN LONDON AND PARIS.—From the French journal *Radioelectricité*, we learn that stations for regular communication between these two cities are located in Neuilly-Levallois, France, and Chelmsford, England. A high-frequency generator of 10 to 25 kilowatts is employed for sending. Signals are first recorded by perforation by means of a special machine upon a strip of paper and are then sent at about a hundred words per minute. The received messages are considerably amplified and are registered upon a fast rotating wax disk similar to that of a phonograph. For transcribing, the disk is revolved much more slowly to enable the operator to copy the message on a typewriter.—*The Scientific American*, 3 September, 1921.

RADIO ABOARD AIRPLANE.—In a recent issue of *Radioelectricité* there are described the various stages of the development or radio communication from and between airplanes. The first satisfactory operating set in French aviation contained a spark coil fed from a 20-volt storage battery. Later the heavy storage battery was superseded by a small air-screw-driven generator running at an average speed of 4500 r. p. m., and delivering 20 volts at 5 amperes. Finally, two types of air-screw-driven 900-cycle alternators were developed, differing only in weight and bulk from each other. Both are rated at 50 volts and 7 amperes at 4500 r. p. m. The machines contain a direct-connected exciter and a tooth-wheeled generator with no rotating windings. A rotary spark gap mounted on the main generator shaft is used on both types.—*The Scientific American*, 3 September, 1921.

AHEAD IN RADIO TUBE WORK.—"I was astonished to find that in wireless development Germany was ahead of us in some respects, especially in tube work," is the summary of two week's study here by Lee De Forest, the wireless inventor, who came here to sell the German rights of his wireless patents. Mr. De Forest has concluded arrangements with the second biggest German wireless corporation, the Huth Gesselschaft Fur, the Funkentelegraphie.

He is enthusiastic about what he has seen here in the way of wireless developments.

"The government wireless station at Königswusterhausen is remarkable," he said. He has 11 transmissions, all operating simultaneously. There is nothing like it in the United States. Königswusterhausen has 10-kilowatt transmission tubes, and is the largest tube station in the world, having larger and better transmission tubes than we have ever been able to make in America, though we invented and started that art. One reason is the extremely low cost of skilled labor, particularly expert glass blowers." Mr. De Forest, who left Berlin to-day for an unknown destination, presumably home, added:

"I am taking back with me some very novel ingenious apparatus which will be extremely interesting to the American radio art, particularly to amateurs, for receiving the broadcast service which the United States Government will shortly inaugurate. The German Government is far ahead of any other in the matter of broadcasting the news of the Stock Exchange, the weather report, etc. The German Government is now building in Berlin 1500 standardized receiving sets, which the government itself will place in various banks and business houses throughout Germany for the reception of this broadcast service. The government also proposes this

winter to send out from the Königswusterhausen station the music from the State Opera in Berlin, which will be heard all over Europe.

"The reception which I have had from all German scientists has been most delightful and cordial. They haven't hesitated to show me anything they had. The German wireless scientists expressed themselves as highly gratified at the reception Einstein received in America. I find working conditions in Germany for anyone engaged in research work far better than in the United States," De Forest added explaining his intention of soon returning to Germany to live and engage in wireless research experimental work.

"By the way," he said, "despite the much touted perfection of the anti-static receiving system in America by the Marconi Company, etc., I find the Service from Germany to the United States very frequently delayed and interrupted for hours, sometimes days. The best German wireless talent admits that the problem of overcoming static is still a long way from solution, either here or in America."—*The N. Y. Times*, 7 September, 1921.

CONCRETE MASTS FOR RADIO.—The Japanese Government is building a powerful radio station at Tokio, one striking feature of which is the reinforced concrete tower for supporting the aerial. The tower is 672 feet high, and of a round, tapering form. It measures about 50 feet in diameter at the base, and about 4 feet at the top. The structure is hollow, of course, with reinforcing bars throughout. The center hollow of the concrete tower is occupied by a steel stairway, which gives access to a balcony near the top, and to four other balconies. The tower was cast by means of a central framework of wood and outside wooden moulds, which were shifted upward as the casting progressed.—*The Scientific American*, 27 August, 1921.

MR. MARCONI, who has recently returned to London, announces that he has been for the last few weeks testing a new method of wireless reception developed by one of the company's engineers which has enabled him to receive continuously from the United States without being in any way interfered with by atmospheric disturbances which are particularly prevalent at this time of year, and more severe than usual in recent weeks in consequence of the abnormal spell of hot weather. Mr. Marconi regards this advance as of the greatest importance, for it enables a wireless telegraph service to be conducted, notwithstanding atmospheric disturbances, during the whole 24 hours and at high speed during the greater part of the time.—*The Engineer*, 19 August, 1921.

RADIO WAVE BAND FOR EVERY COUNTRY.—American backing of wireless telephony was the big thing of the near future revealed in the International Wireless Conference which closed this evening after having been in session for two months.

The American delegation, headed by Major General George O. Squier, Chief of the Signal Corps of the United States Army, came to Paris with a definite program. Most of this program is said to have been adopted, although the conclusions of the conference will be kept secret until they are presented to the various governments by their delegates.

The principal contention of the Americans was that certain bands of waves should be reserved for wireless telephony. This was opposed by the Europeans, as they considered that telephony would occupy too great a part of the usable waves. With the backing of Japan, however, the American viewpoint finally was adopted. The Americans pictured presidents and premiers of the future speaking directly among nations and emphasized the overwhelming importance of wireless telephony in supreme moments, as well as the necessity for aiding in its development.

The activity of the Americans in "selectivity" of the development of the equivalent of the private line in wireless, as opposed to the present "party line," where anyone may listen in on a conversation, met with recognition by the conference.

Among the fourteen principal questions with which the conference dealt and adopted was a recommendation by the Americans that certain waves be assigned in each country, with treaty provisions limiting each country to the use of instruments adapted to those wave lengths, so that the result would be secret wireless.

It was agreed to apportion these waves, probably designating each group by color, so that each country might have the exclusive use of certain colored waves.

It was the opinion of the conference that wireless never would supersede submarine cables, and it advocated the extension of cable facilities. The speedy elimination of state interference, which now is so serious to wireless, was predicted.

The conference emphasized the need of governments interesting themselves in wireless telephony.

The report of the conference, which will fill seven mail bags, offers solutions for problems that were not solved at the Washington Communications Congress. It is believed that this report will be submitted to the Washington Government in November.

General Squier will return to the United States in September to render his personal report. The delegates are leaving to-morrow to visit the French wireless stations.—*The N. Y. Times*, 23 August, 1921.

TRANSMITTING PHOTOGRAPHS AND DRAWINGS BY RADIO.—For some time an interesting series of experiments has been under way at the large radio station at Annapolis, Md., having as the object the transmitting of photographs and drawings by radio to a receiving station at Malmaisson, near Paris, France. This series marks but another step in the development of the Belin system of photographic transmission, which was described in our columns last November when M. Edouard Belin succeeded in transmitting photographs between St. Louis and New York City over the usual telegraph lines. This time, however, the transmission is by high-power radio, which obviously introduces a number of complications.

The Belin principle is quite simple and ingenious. The photograph to be transmitted is tranferred on to a brass cylinder and so treated that its image is reproduced in high relief. The cylinder is then placed in the transmitting unit, where its irregular surface presses against the stylus of a sensitive microphone. The irregular surface varies the pressure on the microphone and hence its electrical resistance, and in that manner modulates an electric circuit in direct proportion to the photographic values. A special synchronizing device sends out a synchronizing signal at regular intervals.

The receiving side consists of a highly sensitive Blondel oscillograph, which carries a tiny mirror on its strings. The strings are placed in oil so as to make them dead-beat, while the mirror swings about on its vertical axis. A source of light casts its rays on the mirror, which in turn reflects them on to a screen of graduated transparency, behind which is a drum covered with a piece of sensitized paper. This drum turns in perfect synchronism with the transmitting drum through the means of the synchronizing signal and special mechanism, which our available space does not permit us to describe here. As the modulated current or signal strength reaches the receiving end, the tiny mirror is deflected more or less so that its beam falls on any part of the graduated screen that corresponds with the image at the transmitting end. In this manner more or less light falls on the sensitized paper of the cylinder, which is then developed in the usual manner.

A simpler transmitter and receiver arrangement calls for a plain make-and-break device at the transmitting end, operated by the surface irregularities, and no graduated screen at the receiving end. This arrangement is for the transmission of drawings, cartoons, facsimile type matter or handwriting, maps, and all other matter in plain black and white, without the half-tone gradations of the usual photograph.

In the present experiments, which are being conducted by Messrs. Marcel Touly and Gaston Johanneau of M. Belin's staff, only plain black-and-white transmission has been undertaken thus far. The difficulties encountered have been mostly in the way of getting the Belin apparatus to modulate the powerful output current of the big arc generator at Annapolis. Over sixty relays have to be actuated in order to handle the transmitting current, and it stands to reason that in this large number of relays some mechanical, electrical and other troubles must arise. The main difficulty is to reduce the lag as much as possible, so that one impulse will not be piled atop the preceding one.

Facsimile handwriting and printed matter have been transmitted by radio to the French receiving station. In fact, it is believed that the greatest application of M. Belin's remarkable system will perhaps be in the direction of greater accuracy, and the facsimile transmission of messages. Column after column of newspaper print or typewritten matter can be transmitted by wire or wireless, and received without a single deviation from the original. Furthermore, because of the high speed of this transmission, it will greatly increase the traffic over our present systems of communication.—*The Scientific American*, 3 September, 1921.

ORDNANCE

FOR "ALABAMA" BOMB TEST.—New weapons of aerial warfare will receive an initial test when the army air service conducts its next bombing operation, a night attack on the old battleship *Alabama*. The present plan is to stage the attack about September 15, probably at the scene of the recent tests upon the former German craft, off the Virginia Capes.

A "light barrage" composed of giant aerial flares, each of more than 200,000 candlepower, will be one feature of the attack. Army engineers have submitted such enthusiastic reports on this weapon that larger flares, estimated to be equal to 1,000,000 candles, have been placed under construction.

Giving a greenish-white light, literally "brighter than day," the flares to be used in the *Alabama* test will illuminate an area of five square miles, and, expert fliers say, should enable the aviators to obtain greater accuracy than in daytime.

The flares are attached to a parachute of white silk, which reflects the light downward with sufficient intensity, it is believed, to blind the officers and gunners of the ship under attack, so as to demoralize any plan for defence, while keeping the upper air reaches shrouded in gloom.

Just before the armistice was signed flares of 2000 candlepower were perfected by the ordnance branch of the army air service. They were equipped with 18-foot parachutes, which kept them aloft while the magnesium burned for a period of from seven to eleven minutes. No opportunity was afforder for a test of these against the enemy, however.

Although disappointed that they cannot have the *Alabama* equipped for battle, with radio control, as they had hoped, the army fliers are exerting every effort to conduct the bombing tests with war conditions as nearly simulated as possible.

It will not be the object of the army pilots to see how quickly they can sink the *Alabama*, officials said to-day, but rather to try out special gas and non-extinguishable phosphorous bombs on her, as well as to ascertain the effect of small demolition bombs. Bombs up to 4000 pounds each may be used.

The *Alabama* is at Philadelphia, and practically ready for delivery to the air service.—*The N. Y. Times*, 2 September, 1921.

NEW TORPEDO WILL RUN WITHOUT WAKE.—An invention which will seriously complicate naval warfare programs is being developed by more than one sea power, including the Japanese. It is the trackless torpedo. It is a torpedo shooting to its mark without leaving a tell-tale wake on the surface, such as is caused by the air bubbles set up by the swift passage of the ordinary torpedo through the water.

The bubbling wake often enabled ships being attacked to avoid the deadly blow by prompt alteration of their courses. To realize what the invention means, one has only to study the reports of naval actions during the war and to read again the stories of those under torpedo fire. Nearly all of them mentioned the "white track of the torpedo."

At the battle of Jutland perhaps a dozen of Admiral Jellicoe's ships were able to save themselves from torpedoes by a timely touch of the helm as soon as the streak of bubbles betrayed the approach and direction of the torpedo. The same thing occurred before that at the battle of Dogger Bank when Admiral Beatty's flagship, *Lion*, avoided torpedoes by changing its course.

Germans Knew Handicap.—The Germans claimed to have fired during the war 5000 torpedoes from U-boats, with 50 per cent hits, and if they had used trackless torpedoes the percentage would have been 80 hits at least. Admiral Jellicoe in his book says: "When the experience of Jutland showed that under favorable conditions the track of German torpedoes was visible for some distance, great care was taken to avoid all mention of this in dispatches, so that future use could be made of the fact. But the Germans knew this handicap and had already devised a type of torpedo which would run under the surface without leaving a discernible track, and this was in the experimental stage at the time of the armistice.

A naval expert is able to give to the public the first details of this weapon and its development. The trackless torpedo is propelled by electricity and not compressed air, and therein lies the secret. With the old torpedo the air was exhausted through the propeller shaft and rose to the surface in large bubbles, which made a track. With electric propulsion there is no exhaust, and consequently no conspicuous track.

Used Special Batteries.—The Germans tried out, late in 1918, a torpedo of 20.18 inches which would travel at a speed of 28 knots, with a range of 2000 yards. This is considerably under the range of the air-driven models, but is sufficient to do the work in most cases. Special storage batteries were manufactured by the Accumulator Fabrik, of Berlin, and a special type of light high speed motor was designed by the Siemons-Halske firm. The trials were very successful. The torpedo ran straight and true, without a perceptible track, the first notice of the approach being given by the explosion as it hit.

The early model was regarded as a beginning, and the Germans were working on one of 25-inch diameter with a range of 10,000 yards, which they figured would increase the efficiency of the U-boats 50 per cent.

The secret was well kept, but members of the allied naval missions scented it out. Previously, however, trackless torpedoes had been designed by France and England, but not built. The Japanese are now known to be giving much attention to this subject and are reported to have produced at the Kure arsenal electric torpedoes with a speed of 30 knots and a range of 6000 yards.

Experts say that the new torpedoes will exert an influence upon naval tactics quite as much as upon torpedoes themselves. A British flag officer who fought at Jutland said:

No Longer Novelty.—"The trackless torpedo isn't a novelty in the sense that it was unforeseen or unexpected. We have always known it to be

inestimable in value, but happily for us the Germans were late with it. Had they used such torpedoes early in the war our naval mercantile losses might have been doubled, and we certainly would have lost more ships at Jutland."

Among the American ships attacked and saved by the wake of torpedoes were the *Florida* and the *Delaware* on February 8, 1918, and the *Arkansas* July 28, 1918. In each of these cases the torpedoes were seen coming and were avoided.—*The N. Y. Herald.*

HEAVY MACHINE GUNS FOR NEW BATTLE PLANE.—Machine guns of a new type, much heavier than any yet used, will protect the giant Siddeley-Cirkis battle plane, which is carrying out trial flights in the neighborhood of Aldershot. They will be mounted in a kind of gallery.

The machine is very fast, considering its size. It weighs nine and one-half tons, and its twin engines develop 900 horsepower. It is so powerful that it will be possible to dispense entirely with the protecting airplanes, which in the past have had to accompany big machines. The pilot and observer travel in the nose of the airplane, and are protected by the circle of machine guns from attack from almost any direction.—*The N. Y. Times,* 1 September, 1921.

MISCELLANEOUS

ARTIC EXPLORATION BY AEROPLANE.—A natural development of the greater reliability of the aeroplane is the decision of an American physicist, Mr. E. F. Naulty, to make a flight over the North Pole in September. The machine which has been specially constructed for the trip, has been designed to carry fuel for a 50 hours' continuous flight at a maximum speed of 100 miles an hour. Three men will accompany the aviator. The route to be followed will be from Point Barrow, in Alaska, *via* Spitzbergen and North Cape, and it is hoped to make several landings during the flight, although it is believed that the machine would be capable of covering the whole distance of 1500 miles between Point Barrow and Spitzbergen in a continuous flight. Plans are in the making to continue the flight from North Cape *via* Scandinavia to London.—*Engineering,* 5 August, 1921.

PSYCHOLOGY AND THE EDISON TESTS.—That the general public should have missed the point of the Edison tests was perhaps inevitable; but one expects better things from a Harvard professor of psychology. Dr. Roback declares that they were merely a test of memory, and of a memory "for things which are useless to mankind in common." It would be more sensible he says, to train a boy in the use of a library of reference books and then set about testing his "brain power."

The Edison tests were intended to measure, not knowledge nor yet mental training, but the subject's "contacts with actuality." A man's mind may be a storehouse of important facts and an instrument of great subtlety and power in the use of those facts, and yet be wholly of the detached and scholastic type. What Mr. Edison was after was the man of the seeing eye and the human touch—the man whose being has a thousand antennæ bringing him news of a world about him. Such antennæ are valuable in the foreman and shop manager, making him vividly alive to his human and material environment. To the inventor and technical expert they are indispensable.

The tests gave Mr. Edison precisely the results he wanted, and he is continuing to use them. They tell him which candidates are and which are not acutely impressionable and retentive of stimuli from without. They are a new and significant phenomenon in the way of examination, and of precisely the kind that ought to interest deeply a professor of psychology.—*The N. Y. Times,* 10 August, 1921.

RADIUM IN INDUSTRY.—Radium, the most mysterious and most powerful of all discovered sources of energy, has now been linked with the safety movement, and will lend its inexhaustible power to the prevention of avoidable accidents. The power of radium was made known only a few years ago through the discoveries of Mme. Curie who recently returned to France after a tour of this country.

Radium's rôle in industry as a life saver is important. The great mass of accidents in factories, in mines and in other industrial institutions where darkness is a creator of danger, are being eliminated through the newest invention of science—undarkradium luminous material.

Power-line switches, where fumbling might mean electrocution to the operator, are now illuminated with radium. Gauges—high pressure, steam and water electric switches, fire alarms and fire extinguishers are made visible through the magic of radium.

While radium is the most valuable element in the world—a gram of radium, which is about a thimbleful, cost $120,000—it is so powerful when mixed with other materials that even the most minute particle is effective in making material self-luminous for years. It is this quality which makes radium luminous material commercially possible.

When other lights fail, when fuses blow out, wires break down, radium will glow dependably, without danger of explosion or of burning. The employment of radium to help solve our medical industrial problems of life-safety is as yet in the first stages of its development. What the future will bring, no one knows.—*The N. Y. Times,* 28 August, 1921.

SECRET OF GERMANS DIVINED BY CHEMIST.—Dr. William Henry Nichols, a noted manufacturing chemist and Chairman of the Board of Allied Chemical and Dye Corporation, announced yesterday at the sixty-second meeting of the American Chemical Society in this city that his company, through the ingenuity of American chemists, had duplicated one of the dearest secrets of the Germans—that of manufacturing nitrogen products from the nitrogen of the air.

The chemist sent out the announcement that the new method was being operated on an industrial scale and that the country could be virtually independent of the Chilean nitrates formerly indispensable in the manufacture of explosives, dyestuffs and fertilizer. The Germans used a similar process on a vast scale during the war.

"This process is the extraordinary 'fixation' of atmospheric nitrogen and 'synthetic production' of nitric acid and nitrates generally which have so greatly interested chemists and chemical manufacturers during the last few years," said the announcement. "Although Germany succeeded in doing it during the war—indeed, it is said that without it she could not have continued the war for six months—the accomplishment is an entirely new one outside of Europe, and marks an important step in the progress of the American chemical industry."—*The N. Y. Times,* 8 September, 1921.

CURRENT NAVAL AND PROFESSIONAL PAPERS

Tactical Organization and Employment of Anti-Aircraft Searchlights. *Journal of the United States Artillery,* August, 1921.

Some Technical Problems in Aeronautics. *Mechanical Engineering,* August, 1921.

Internal Combustion Engines in Marine Service. *Journal of the Franklin Institute,* August, 1921.

A Course-Setting Bomb Sight. *The Engineer,* 19 August, 1921.

Locating Faults in Direct-Current Armatures—Coils and Windings. *Power,* 6 September, 1921.

Airplane Bombing. *Army Ordnance,* July-August, 1921.

Improvements in Methods of Fatigue Testing. *The Engineer,* 12 August, 1921.

NOTES ON INTERNATIONAL AFFAIRS

FROM AUGUST 10 TO SEPTEMBER 10

PREPARED BY

PROFESSOR ALLAN WESTCOTT, U. S. Naval Academy

WASHINGTON CONFERENCE

FINAL ACCEPTANCE OF POWERS.—The formal invitations issued by the United States Government for a conference on limitation of armaments and on Pacific problems were accepted by all the nations included. China's acceptance, published on August 18, took special note of the fact that China was to appear on an equality with other powers. The British note, received on August 22, expressed the hope that the conference, approached "in a spirit of courage, friendliness, and mutual understanding," would achieve far-reaching results. The reply from Tokio, published on August 24, again referred to preliminary negotiations for limiting the scope of discussions regarding the Far East. A despatch from Tokio on August 31 stated that the Japanese would insist on excluding from the agenda the following: first, the Kwang-tung leased territory; second, the operation of the Manchurian railway; third, Kiao-chau, which will be returned to China; and fourth, the question of Yap.

Premier Lloyd George, speaking in Parliament on August 18, suggested that "if the alliance with Japan could emerge into a greater understanding with Japan and the United States on all problems of the Pacific, that would be a great event which would guarantee the peace of the world." He added that the Imperial Conference had agreed that the British naval force should at least equal any other.

AMERICAN DELEGATES.—Secretary Hughes was made the head of the American delegation for the conference in Washington, and Senator Lodge was named as a second member. In a letter on September 7, President Harding indicated that only four delegates would be named, Mr. Elihu Root and Senator Underwood completing the number.

PAN-AMERICAN BUILDING TO BE USED.—Secretary Hughes on August 26 accepted the offer of the Pan-American Building for the meeting place of the Washington Conference. The army and navy and other government buildings will also be used for offices of the visiting delegations.

Upon a rumor that French would not be recognized as an official language at the conference, Premier Briand declared to the French Academy on August 24 that he had received assurances to the contrary, and that the

French Government could not under any circumstances take part in a conference in which the French language was not recognized. The statement of President Wilson in 1919 was recalled in this connection; advocating the recognition of English as an official language together with French, he referred to English as "the diplomatic language of the Pacific."

NEGOTIATIONS OVER YAP.—While negotiations between the United States, Japan and other Allied powers were progressing, no settlement of the Yap cables question had been reached at the close of August. From Tokio came a report that the probable basis of agreement would allow Japan to retain the mandate over the island, give the United States control over the cable from Yap to Guam, and recognize Holland's interest in the cable between Japan, Yap, and Mendano (Dutch).

PEACE TREATY WITH GERMANY.

TREATY SIGNED IN BERLIN.—The peace treaty between Germany and the United States was signed in Berlin on August 25 by Dr. Friedrich Rosen, German Foreign Minister, and Ellis Loring Dresel, the American Commissioner. The treaty is in accord with the peace resolution adopted by Congress on July 2, 1921, and the preamble repeats the parts of this resolution relating to Germany. The remainder of the treaty follows:

Article One.—Germany undertakes to accord to the United States, and the United States shall have and enjoy, all the rights, privileges, indemnities, reparations or advantages specified in the aforesaid joint resolution of the Congress of the United States of July 2, 1921, including all the rights and advantages stipulated for the benefit of the United States in the Treaty of Versailles which the United States shall fully enjoy notwithstanding the fact that such treaty has not been ratified by the United States.

Article Two.—With a view to defining more particularly the obligations of Germany under the foregoing article with respect to certain provisions in the Treaty of Versailles, it is understood and agreed between the High Contracting Parties:

(1) That the rights and advantages stipulated in that treaty for the benefit of the United States, which it is intended the United States shall have and enjoy, are those defined in Section One, Part Four, and Parts Five, Six, Eight, Nine, Ten, Eleven, Twelve, Fourteen and Fifteen. The United States, in availing itself of the rights and advantages stipulated in the provisions of that treaty mentioned in this paragraph will do so in a manner consistent with the rights accorded to Germany under such provisions.

(2) That the United States shall not be bound by the provisions of Part One of that treaty, nor by any provisions of that treaty including those mentioned in Paragraph One of this Article, which relate to the Covenant of the League of Nations, nor shall the United States be bound by any action taken by the League of Nations, or by the Council or by the Assembly thereof, unless the United States shall expressly give its assent to such action.

(3) That the United States assumes no obligations under or with respect to the provisions of Part Two, Part Three, Sections Two to Eight inclusive of Part Four and Part Thirteen of that treaty.

(4) That, while the United States is privileged to participate in the Reparation Commission, according to the terms of Part Eight of that treaty, and in any other commission established under the treaty or under

any agreement supplemental thereto, the United States is not bound to participate in any such commission unless it shall elect to do so.

(5) That the periods of time to which reference is made in Article 440 of the Treaty of Versailles shall run with respect to any act or election on the part of the United States from the date of the coming into force of the present treaty.

Article Three.—The present treaty shall be ratified in accordance with the constitutional form of the High Contracting Parties and shall take effect immediately on the exchange of ratifications, which shall take place as soon as possible at Berlin.

In witness whereof, the respective plenipotentiaries have signed this treaty and have hereunto affixed their seals.

Done in duplicate in Berlin, this 25th day of August, 1921.

The treaty was framed with the aim of securing for the United States all rights and privileges acquired by other nations in the Versailles Treaty, so far as desirable, while freeing her from responsibility in connection with matters of European concern. The treaty explicitly confirms the right of the United States to take part in the disposition of Germany's overseas possessions on an equality with other allied powers. From France came the suggestion that the treaty raised the need of another agreement between America and the Allies, giving American sanction to the disposition of European affairs made in the Treaty of Versailles.

AUSTRIAN AND HUNGARIAN TREATIES.—A peace treaty with Austria, based on the Treaty of St. Germain much as the German treaty was based on that of Versailles, was signed in Vienna on August 24. Negotiations for a similar treaty with Hungary were also reported in progress.

LEAGUE OF NATIONS

LEAGUE COUNCIL ACTS IN SILESIA.—By a vote of the Interallied Council on August 12, following failure to reach an agreement on the Silesian problem, its settlement was left to the Executive Council of the League of Nations, the Allied Powers binding themselves to abide by the League decision. Ambassador Harvey, who was present, did not vote, but stated that since the matter was one of distinctly European concern, the President of the United States would hear with relief of its being referred "to a body with which the United States is not associated."

After discussing the Silesian question in an extraordinary session on August 29, the League Council turned it over to a special committee composed of Paul Hymans of Belgium, V. K. Wellington Koo of China, Count Quinones de Leon of Spain, and Dr. Gastoa de Cunha of Brazil.

In view of possible dismemberment of Upper Silesia, both Poles and Germans of that region got together in an agreement on August 17, pledging cooperation in the interest of their "common motherland," and favoring an undivided Silesia whether awarded to Poland or Germany.

MEETING OF LEAGUE ASSEMBLY.—The second Assembly of the League of Nations met at Geneva on September 5. Dr. Koo of China opened the

session as temporary president and Foreign Minister A. Van Karnebeek of Holland was elected permanent president. Of the 48 countries in the League 39 were represented; the delegates of Peru, Hayti, and Costa Rica were reported on the way; and Argentina, Guatemala, Nicaragua, Panama, Honduras, and Salvador sent no delegates. The five new nations represented were Austria, Bulgaria, Albania, Finland, and Luxembourg.

TACNA-ARICA DISPUTE INVOLVES MONROE DOCTRINE.—The League Assembly was put in a difficult position by the appeal of Bolivia that the League consider whether it could properly take up the dispute between Bolivia and Chili over Bolivia's claim for an outlet to the sea. By a treaty in 1904 between Bolivia and Chili the former country was shut off from the sea. Bolivia has demanded that the treaty be revised, claiming a just settlement would give her an outlet. Chili insisted that the question should not come before the League in any form, first on the ground that the League could not properly engage in the revision of treaties, and second, on the ground that the Monroe Doctrine prevents non-American countries from interference in questions exclusively affecting the New World.

NEW AMERICAN MANDATE NOTE.—At the request of the Allied Powers Secretary Hughes in August formulated a new note on mandates setting forth in detail the views of this country regarding both Class A and Class B mandates. The note reiterated the American demand for an "open door" to all powers (not merely those in the League of Nations) in all mandate territories, and the right of the United States to be consulted in all questions regarding mandates. It insisted that even though the United States did not declare war on Turkey, it aided in her defeat and therefore should have an equal voice with other powers in the disposal of former Turkish territories.

FORMATION OF WORLD COURT.—For the 11 judgeships in the proposed world court, 91 names had been put in nomination when the League Assembly met at Geneva. Among the more prominent American nominees were Elihu Root, James Brown Scott, and John Bassett Moore. Mr. Root declined to be a candidate on account of his age. Last year the major powers blocked the principle of compulsory jurisdiction. Unless this is adopted, no case can be brought before the court without the consent of both nations concerned.

GREAT BRITAIN AND IRELAND

IRISH REPLY UNFAVORABLE.—The Irish republican parliament or Dail Eireann met on August 16 to consider the terms presented by Premier Lloyd George after conferences with Mr. de Valera in London. Following secret sessions of the Dail Eireann, Mr. de Valera sent a note on August 24 in which he stated that the terms had been rejected by a unanimous vote. The note declared that "geographical propinquity" could not, as the British minister insisted, "impose the condition of the subordination of Ireland's rights to Great Britain's strategic interest." If this principle

were followed, according to the note, no small nation such as Holland or Belgium would have the right to exist.

In reply Premier Lloyd George kept to fundamental principles. He declared that the terms were liberal beyond all precedent, were so regarded by the whole civilized world, and offered Ireland a partnership in the British commonwealth of free nations, with government by consent of the governed. He cited Lincoln's words on the impossibility of separating the North and the South, and quoted the Irish patriot Grattan who wrote, "the ocean protests against separation and the sea against union."

The final verdict of the Dail Eireann, contained in a note published on September 4, declared that the Irish people by an overwhelming majority had decided in favor of independence; that the British proposals offered Ireland "a status definitely inferior" to that of other British dominions, "dividing her into two artificial states, each destructive of the other's influence in any common council, and both subject to military, naval, and economic control by the British Government"; and finally, that Ireland was willing to continue negotiations only on the principle of "government by consent of the governed."

BRITISH PROPOSE ANOTHER CONFERENCE.—After a meeting in Scotland the British Cabinet on September 7 sent a reply to Ireland declaring that the principle of government by consent of the governed could not be taken to mean the right of any body of people to set up any form of government it pleased, or the right of Ireland to renounce its allegiance to the Crown. The reply closed by calling for a definite answer whether or not discussions were to continue and suggesting September 20 as the date for a conference at Inverness, Scotland.

BELFAST RIOTING.—At the close of August, disturbances were renewed between Orange and Sinn Fein factions. Snipers on both sides shot down opponents in the streets. On August 31 there was a toll of 15 killed and scores wounded. Order was restored by reinforcements of troops.

GERMANY

CURB ON REACTIONARIES.—At the end of August the German Government issued decrees prohibiting meetings, processions, demonstrations, and publication of periodicals likely to encourage seditious movements, and started a vigorous campaign against monarchist opposition. Several anti-republican journals were suppressed. On August 31 there was a demonstration of over 100,000 members of the Social Democratic, Independent Socialist, and Communist parties. The action of the republican government on the whole increased its strength and prestige, with a rallying of all moderate elements, including the German People's party, behind the government and in support of execution of the treaty terms. Herr Stresemann, leader of the People's party, pledged support for the republican government against "violent overturn."

ERZBERGER ASSASSINATED.—On August 26, Matthias Erzberger, German Centrist politician, was shot to death by two assassins while he was walking with a companion in the Black Forest. Erzberger, after having been driven into retirement by the attacks of his opponents, had planned to reenter politics in support of the Wirth government.

AUSTRIA

AUSTRIAN OCCUPATION OF BURGENLAND RESISTED.—The march of 8000 Austrian troops into the Mattesdorf district of Burgenland, assigned to Austria by the peace settlement, was resisted at the close of August by a large body of irregular Hungarian forces under Captain Hejas and other insurgent leaders. The advance of Austria was halted in the expectation of pressure upon Hungary by the Allied Powers.

AMERICAN AID URGED.—Paris, September 4.—Samuel Untermyer is the latest to urge that the United States remit Austria's debt for such a period as will give that unfortunate country opportunity to recover. Eight months ago the Allied Powers, through the Finance Committee of the League of Nations, began work in this direction, each promising that it would remit all claims for fifteen or twenty years, and the State Department was asked if the American Government would take a similar step with regard to the $22,000,000 which Austria owes America on account of food relief work.

Conditionally on America's replying in the affirmative, the League's Finance Committee worked out a scheme for the advancing of private loans to Austria on her national securities and with a certain control over her expenditures. That scheme has, however, never become possible, because no reply has been received from the American Government to the proposal of the committee. Some weeks ago the Council of Ambassadors was asked to approach the State Department to see if it could draw a reply; but since then nothing has been heard of the matter.—*N. Y. Times*, 5 September.

RUSSIA

AMERICAN RELIEF AT WORK.—On August 18, Secretary Hoover, as head of the American Relief Association, was informed that an agreement had been signed at Riga by the American representative, Mr. Walter Lyman Brown, and Maxim Litvinoff, the Soviet envoy. By the terms of the agreement, the American organization secured complete control of the distribution of relief at all points in Russia. This differed from the arrangement made by Dr. Nansen on behalf of Allied relief organizations, which turned over the distribution of supplies to the Soviet Government.

At the close of August the All Russian Famine Commission headed by Maxim Gorky was dissolved, some of its members arrested, and its work taken over by the Soviet authorities. The latter claimed that certain members of the Gorky Commission planned to carry on anti-Soviet propaganda outside of Russia.

NEAR EAST

ALEXANDER ASCENDS JUGOSLAV THRONE.—Following the death of King Peter of Jugoslavia, his son Alexander ascended the throne and on August

22 issued his first royal proclamation recalling the great work of his father in the unification of the Slav peoples, and guaranteeing the constitutional rights and privileges of his citizens.

GREEK OFFENSIVE SUCCESSFUL.—Through August and early September the Greek advance against Turkish Nationalists in Asia Minor met with continued success. The Turks evacuated Ismid on August 17. At the close of August the Greeks were in a 40-mile front before the last defenses of Angora east of the Sakaria River.

On August 10 the Allied Supreme Council decided to throw aside the Sévres Treaty and let the Greeks and Turks fight it out. The Allies declared strict neutrality, while permitting private traffic in arms with both belligerents, and taking measures to maintain control of the Straits.

LATIN AMERICA

PANAMA SURRENDERS TERRITORY.—On August 18, Secretary of State Hughes sent a note to Panama announcing that the United States Government had suggested to Costa Rica that it occupy, at once, the territory assigned it by the Loubet award. At the same time a battalion of marines was sent to reinforce the American troops in the Canal Zone. Finding that it was the intention of the American Government to prevent hostilities in the disputed area, Panama ordered the evacuation of Coto and it was peacefully occupied by the Costa Rican authorities. In a parting message, Foreign Minister Garay of Panama, special envoy in Washington, complained of the injustice of the American action in forcing the peaceful settlement.

According to the Porras-Anderson Treaty between Costa Rica and Panama, one Costa Rican, one Panamanian, and two American Commissioners were to be named to lay down the boundary line in accordance with the White award. Accordingly, Chief Justice Taft named Prof. J. F. Hayford of Northwestern University and Prof. O. W. Leland of Cornell as the American engineers. It was regarded as probable that the line would be laid down, even if a representative of Panama were not named.

FAVORABLE MEXICAN OIL RULING.—On August 30 the Mexican Supreme Court handed down a decision debarring Mexican authorities from denouncing oil rights held by the Texas Oil Co. prior to May 1, 1917. This decision apparently established definitely the non-retroactive character of Article 27 of the Mexican Constitution providing for the nationalization of petroleum deposits.

President Obregon on September 1 declared a treaty with the United States "neither possible, convenient, nor necessary." As a matter of fact, the court decision lessened the need of further treaty guaranties.

A conference between American oil officials and the Mexican Government concluded on September 3 with an agreement regarding the collection of the new export tax and resumption of oil exportation.

SPECIAL NOTICE

NAVAL INSTITUTE PRIZE ARTICLE, 1922

A prize of two hundred dollars, with a gold medal and a life-membership (unless the author is already a life member) in the Institute, is offered by the Naval Institute for the best original article on any subject pertaining to the naval profession published in the PROCEEDINGS during the current year. The prize will be in addition to the author's compensation paid upon publication of the article.

On the opposite page are given suggested topics. Articles are not limited to these topics and no additional weight will be given an article in awarding the prize because it is written on one of these suggested topics over one written on any subject pertaining to the naval profession.

The following rules will govern this competition:

1. All original articles published in the PROCEEDINGS during 1921 shall be eligible for consideration for the prize.

2. No article received after October 1 will be available for publication in 1921. Articles received subsequent to October 1, if accepted, will be published as soon as practicable thereafter.

3. If, in the opinion of the Board of Control, the best article published during 1921 is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention," or such other distinction as the Board may decide.

4. In case one or more articles receive "Honorable Mention," the writers thereof will receive a minimum prize of seventy-five dollars and a life-membership (unless the author is already a life member) in the Institute, the actual amounts of the awards to be decided by the Board of Control in each case.

5. The method adopted by the Board of Control in selecting the Prize Essay is as follows:

(a) Prior to the January meeting of the Board of Control each member will submit to the Secretary and Treasurer a list of the articles published during the year which, in the opinion of that member, are worthy of consideration for prize. From this a summarized list will be prepared giving titles, names of authors, and number of original lists on which each article appeared.

(b) At the January meeting of the Board of Control this summary will, by discussion, be narrowed down to a second list of not more than ten articles.

(c) Prior to the February meeting of the Board of Control, each member will submit his choice of five articles from the list of ten. These will be summarized as before.

(d) At the February meeting of the Board of Control this final summary will be considered. The Board will then decide by vote which articles shall finally be considered for prize and shall then proceed to determine the relative order of merit.

6. It is requested that all articles be submitted typewritten and in duplicate; articles submitted written in longhand and in single copy will, however, receive equal consideration.

7. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

F. M. ROBINSON,
Commander, U. S. N., Secretary and Treasurer.